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Volume 22, No. 5

EDITORIALS

Agricultural Objectives

OBJECTIVES in agriculture are social and economic, and not defined or agreed upon in detail so clearly, accurately, and unanimously as desirable from the standpoint of workers in the more quantitative fields of applied natural science to whom agriculture looks for help. We need to know more surely where agriculture wants to go before we can proceed more directly, cooperatively, and effectively to help it get there.

Agricultural objectives set the tasks to be accomplished by the applied scientists working in and for agriculture and related business. Only by having these objectives clearly in mind can we confidently recognize our tasks and the logical approaches to their accomplishment. By way of working toward substantial agreement with leading farmers, and between workers in the specialized fields of agricultural science, we need, as a basis for discussion and collaboration, new tentative statements of desirable objectives in agriculture. Here is ours:

1 *Increased Productivity.* This means aiming toward performing in and through agriculture and related business, an ever larger and better economic service. It means aiming toward increased desirable use of available organic resources by increasing the variety, quality, and usefulness of farm products; putting them more nearly in condition for use by the ultimate consumer; and reducing waste. It implies aiming at a more selective production to meet changing market demand, development of potential market demand for new and improved products; and development of economic opportunity for increased total quantity production Socially it means aiming to make the supply of farm produced organic materials for food, clothing, and other uses, less of a limiting factor in human welfare and progress. It means increasing opportunity for people to work usefully and live satisfactorily.

2 *Increased Farm Work Effectiveness.* Continued progress in this direction is important to enable farm people to have more time and means for seeking and realizing more of the material, mental, moral, and spiritual satisfactions of life; to make farm life and work more attractive to the best elements of new generations; and to make the obtaining of farm produced necessities, comforts, and luxuries less of a problem to that proportion of the population which is concerned with nonagricultural aspects of human progress—education, science, the learned professions, the arts, mining, manufacturing, transportation, and other phases of civilization as we know it or would like to enjoy it. It means aiming to develop and apply more scientific knowledge to improve the biological organisms of farm production, and the agencies and methods by which the farmer aids and controls organic production and makes the products available for use. It is a means of increasing productivity. It is the alternative to peonage. It is conservation of human values.

3 *Improved Human Relations.* This calls for a more complete, widespread, and accurate application of the principles of democracy, individual rights, individual responsibility, the Golden Rule, business and professional ethics, and neighborliness. It counts on free private enterprise to provide the incentives and methods of progress. It implies decreased class consciousness; increased protection and respect for individual rights; and increased appreciation of the economic interdependence of individuals and of whole industries. It calls for more widespread appreciation of the economic fact that wealth is a limited and perishable substance, being continually redistributed, used up, wasted, and recreated by the combined application of labor, capital, and management to natural resources. It implies less quibbling about distribution of wealth and more attention to individual effectiveness in the production and conservation of wealth. It depends on individual freedom, integrity, self-reliance, ingenuity, and voluntary cooperation to make the abuse of good human relations by any individual or minority an unprofitable and unsatisfying practice. It implies improvement in farm homes, home utilities, and working conditions as accessories to desirable human relations. It recognizes that satisfying human relations originate in the minds, hearts, and work of men.

To the extent that farmers, related business, agricultural engineers, and other applied scientists could agree on these or other points as desirable general objectives for agriculture, such agreement would provide a yardstick by which specific applications of natural science in agriculture could be measured. It might reveal more tangibly a unity of purpose and basis for cooperation in the applied sciences, business, and life related to agriculture. It might help individuals to orient, evaluate, and direct their own professional or vocational objectives and efforts in relation to that unity of purpose. And it might provide a fair representation to the world of the considered viewpoint of a group of well-balanced realistic and idealistic thinking men on some currently important questions.

Agricultural and Chemical Engineering Relationships

AT the recent annual chemurgic conference we were impressed with the probability that in a few more years it may be hard to tell where the agricultural engineering of farm product use leaves off and its chemical engineering phases begin.

Agricultural engineering already involves some physical factors in production, harvesting, and delivering the quality of organic raw materials which chemical engineers want for industrial processing operations. It involves the handling of some chemicals, such as fertilizers and insecticides, and may come to involve some distinctly chemical initial processing operations on farms or in farm community plants. On the other hand, chemical engineering clearly involves many physical operations such as grinding, pressing, and separating, for controlling the conditions under which chemical reactions take place and for concentrating the products of these reactions. These may move closer to farm sources of materials.

Still we anticipate no important jurisdictional disputes between agricultural and chemical engineers. Both will work wherever they see opportunity for service. To be sure that the borderline area between these two branches of engineering in dealing with the same materials and general problems is adequately covered, and to be sure that they understand each other well enough to cooperate effectively, there will and should be some beneficial overlapping and dovetailing of their work. The important consideration is not that certain border-line work be done by one group or another, but that it gets done, and that the "talents" given us in the form of organic resources be utilized more effectively for the benefit of mankind.

In any new processing development, the availability, quality, and cost of raw materials cannot be taken for granted. The chemical reactions which may be scientifically possible or technically usable *(Continued on page 169)*

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Some Engineering Implications of High-Speed Farming

EDITOR'S NOTE: The symposium on high-speed farming was introduced by E. J. Baker, Jr., (Member A.S.A.E.) associate editor of *The Farm Implement News,* who sketched briefly the historical background of the trend, starting with the adoption of the motor car when the low-priced group first made possible farmer ownership.

This was not coincident, he said, with the advent of power farming, for tractors had long been used in certain types of agricultural work, but they were massive machines with travel speeds not materially faster than the animal power displaced.

High-speed power farming, said the speaker, was generally deprecated by the industry as uneconomic and potentially hazardous. Despite these sound objections, farmers wanted speed both to attain better timeliness of operations and also to gratify their craving to go fast.

General recognition that a faster tempo was essential to meet consumer reactions came with the adoption of pneumatic tires for tractors in 1932 and thereafter. Pneumatic tires on drawn machines and implements soon came into use, justifying their increased cost by the reduction in shock and breakage, the faster gait at which many operations could be performed, and the mobility of such equipment in getting from field to field and farm to farm over hard roads.

This speedup in farm operations, concluded the speaker, has probably not run its course. It seems to be but one phase of a world trend manifest in everything from war to industry.

Contribution by C. J. Scranton

MEMBER A.S.A.E.

CERTAINLY the farm equipment industry as a whole has done some good work during the past twenty-five years and many of the newer tools have made those of a few years back completely obsolete. Tractor design has probably shown the most progress. It has developed from the cast iron, exposed-gear stage, of limited service, to the modern tractor with cut gears and all parts running in oil. The tractor of today is probably better made than a good automobile and stands up longer under punishment. Other farm tools have shown similar progress.

I think we can all agree that the tempo of agricultural operations has been increased. I think we can also agree that the farmers of today would like to have faster tools if they could get them. The engineering profession is well aware of this and is today feverishly trying to build such equipment.

Apparently there is need for a new phrase to adequately describe the more efficient methods and improved machinery of modern farming. Many of us think the words "high speed" are misleading and belong to that field in which efficiency is measured by miles per hour. One is apt to think of an automobile operating at speeds of 75 mph or an airplane going places at 200 mph. Some of the service reports on our products would indicate that the farmer has these things in mind. It is well to remember that when you hook on to a farm tool, there is work to be done and the going is not through ether waves or on a paved highway.

I am certain that any forward-looking engineer wants to build faster and better equipment. At the same time he is always reminded that this better equipment must be produced at less cost to conform to farm income. This presents some interesting problems. Farm machinery is not built by the use of big words, by rubbing an Aladdin's lamp, or by gazing into a crystal ball. Future tools are dependent upon some foresight and more hard work. Our laboratory is the wide open spaces, and there are many things which cannot be calculated on a slide rule.

Suppose we examine some of the factors affecting present design and performance. Then, perhaps, we can make a few suggestions about future trends. Many field operations have already been stepped up to speeds of from 4 to 5 mph. Some have even gone from 8 to 10 mph. On the other hand, there are still a few where a low low gear in the tractor would be preferable. Speeds have to be adjusted to the work to be done and these speeds vary greatly according to territory and conditions. We can build fast equipment for limited sections of the United States and the rest of the world where conditions are unfavorable, but this same equipment would be prohibitive in cost to farmers as a whole.

Human reactions to the operation of controls on present-day machines seem to be geared to speeds of from 4 to 5 mph. When we increase this speed, we will need to give the problems of safety some serious consideration. A lever not reached in time or a ditch not quickly seen may cause a serious accident. Perhaps we will use push buttons instead of levers and perhaps we can design cultivating tractors with

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Contributions to a symposium before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 3, 1940. Authors: Mr. Scranton is chief engineer of harvester division, Allis-Chalmers Mfg. Co. Mr. McCormick is chief engineer of John Deere Tractor Co. Mr. Burr is operator-manager of Upper Gwynne Farms, London, Ohio. Mr. Heitshu is an engineer of J. I. Case Co.

lower centers of gravity. In any event, safety will be an important factor.

At this point I would like to suggest that the engineer has a right to expect more cooperation from the farmer. I believe we have the right to expect him to assume the responsibility of preparing better seedbeds, so that when the harvest comes, our machines won't go bouncing over the ground like kangaroos. I believe we should expect him to remove stumps from his fields and to remove the hazards of bad ditches through better drainage. Perhaps, too, we may expect better use of our equipment through better understanding of it. Sometimes we wonder if our instruction books are worth while. We get the impression they are seldom read. Some day we may design equipment which requires no operating instructions, but we have not yet reached that point.

We would like to see quality of work put on a par with quantity. Certainly the number of acres gone over is not the measure of a machine's efficiency. We wish our custom operators would constantly keep this thought in mind.

In many respects the engineer of today is in a much more fortunate position than those of a few years ago. He has a choice of materials to work with undreamed of twenty years back. The first of these, of course, is the rubber tire. You can't even begin to talk speed without it. Rubber cushions shock, prolongs life, and makes possible the design of lighter equipment. Why not use more of it? We also have the V-belts for power transmission, alloy steels, metal for deep drawing, and a multitude of other advantages. All of these things make possible the building of the machinery of tomorrow. When properly harmonized and wisely used, these materials mean light weight, lower cost, longer life, more economy of operation, and faster speeds. Combine them with the experience of today, plus a new horizon, and we ought to go places.

While we are looking forward to the equipment of tomorrow, let us venture a few suggestions which might speed up farm operations without increasing the speed of ground travel.

Why not eliminate time taken for greasing by eliminating grease connections?

Why not make our power take-off equipment so that any make of implement can be quickly coupled to any make of tractor without the need of special hitches and hook-up parts?

Why not design our tractor-mounted equipment for speedier installation or removal, leaving the tractor free for other operations?

Why not consider some new tools where one piece of equipment will replace two or more already in existence?

Suppose we make the implement and tractor controls so that an operator has less strain on his neck and the seat of his pants. He probably could get more work done if he didn't need extensions on his arms or legs. Maybe we can do something about his comfort in other ways.

Some of us dare venture to suggest that brand new types of equipment are not so far away. We expect to see more progress in the next ten years than has been made in the last forty. There is still challenge and romance in the farm machinery business. Just how smart are we?

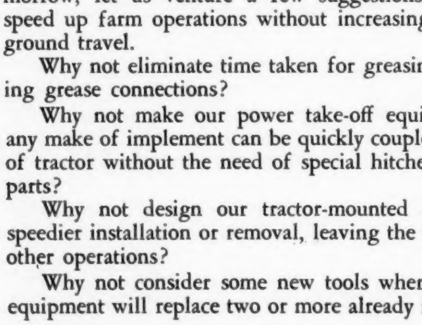
Contribution by Elmer McCormick

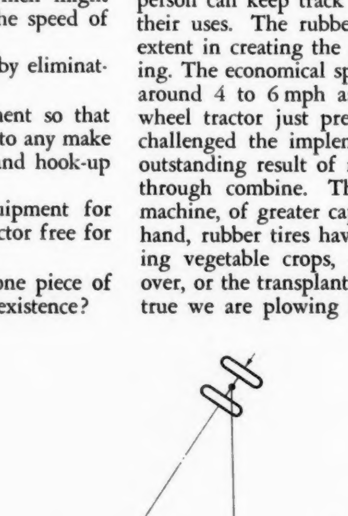
MEMBER A.S.A.E.

WE FREQUENTLY hear remarks that this is the age of speed, and that is true to some extent, but it was also true one hundred years ago when travel was taken off of foot and hoof and placed upon the mechanical marvels of the age—the railroad train and steamboat. I think the matter of speed then was more marvelous and awe-inspiring than now. We still get a thrill when these new streamline trains pass or marvel at the speed of the combat planes in the air, yet calmly get into an airplane here in Chicago and arrive in New York in four hours and think nothing about it. After all speed is an ordinary thing accepted as such in our daily life, and high speed at best is only relative. It is like asking the old saw, "How high is up?"

We in industry must recognize consumer demand to stay in business, and, on the other hand, play a part in creating this demand. The world didn't demand the invention of the machine. Farmers resented the first automobiles. Bankers advised farmers not to buy tractors. Yet today we are not concerned with a horse-and-tractor controversy but by a passing phase in the development of the machine.

Development is a progressive thing. Industry is expanding the availability of materials. Take metals alone; no one person can keep track of the infinite variety of alloys and their uses. The rubber industry is responsible to a large extent in creating the present higher speed trend of farming. The economical speed of a rubber-tired tractor today is around 4 to 6 mph as against 3 to 4 mph for the steel-wheel tractor just preceding. This increase in speed has challenged the implement manufacturer to meet it. One outstanding result of meeting this demand is the straight-through combine. The farmer has been given a better machine, of greater capacity and lower price. On the other hand, rubber tires have not changed the speed of cultivating vegetable crops, such as head lettuce the first time over, or the transplanting of cabbage and other crops. It is true we are plowing faster than we formerly did, but to





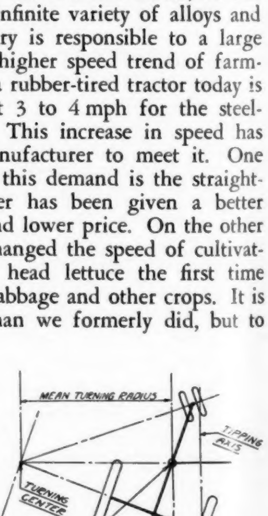
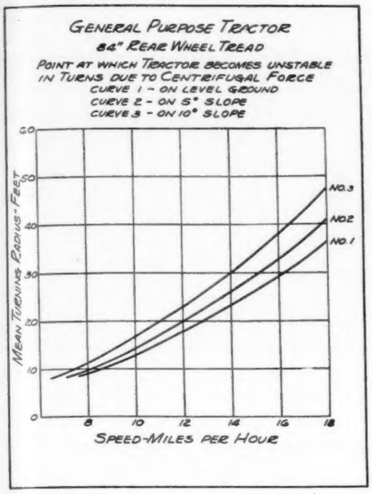


Fig. 1 (Above) and Fig. 2 (Center) Center of gravity locations. Fig. 3 (Right) Influence of turning on stability



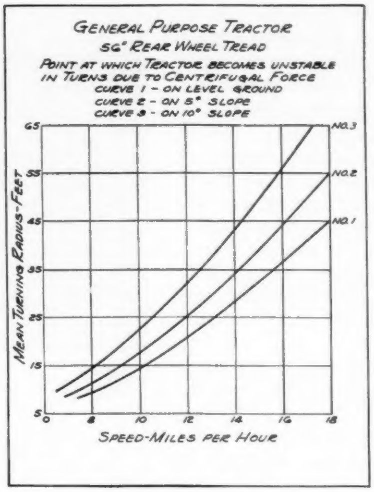


Fig. 4 (Left) and Fig. 5 (Right) Stability curves for different rear wheel tread widths, as influenced by slope of ground, turning radius, and speed

date draft of plows per square inch of furrow slice is still greater at 4 than at 3 mph, and many so-called high-speed bottoms actually pull heavier than those not so named.

One thing we are sure of; that farm operations will have to be done as well or better at these higher speeds. Higher speeds will reduce the size of the tractor and implements of the future, which should reduce their cost, and aid the farmer in keeping down his machinery investment.

To me the problem of utilizing higher speed is that of control. Today we drive automobiles which can go over 100 mph. Such speeds can be used safely only on a straight road with no traffic. Fifteen years ago our usual speed on the highway was 45 mph, whereas today it is around 65 mph. This increase is occasioned by better highways and better automobiles having lower center of gravity, better steering, and better braking. The answer lies in control and a feeling of safety in driving at these higher speeds.

We have seen the speeds of tractors increased by the addition of extra speeds. We have seen this occur with some misgivings, yet at the same time recognizing that farmers with large acreage or those farming isolated plots at a distance had a real requirement for them. Safety-first stickers now appear on all tractors urging caution under various conditions. Instruction books are full of additional statements urging caution. Our own company made an analysis of the speeds at which general-purpose tractors became unstable. I would like to give you the results of this analysis.

Fig. 1 outlines a typical general-purpose tractor having a center of gravity 32 in above the ground and 28 in forward of the rear axle. The tractor (Fig. 2) is supported by the four wheels by forces acting normal to the surface of the ground at the points that the tires contact the ground. Obviously the tractor is stable only when the force (gravity) acting through the center of gravity falls inside of the lines connecting the points of contact of the wheels with the ground. When making a turn, other forces are put into action and the forces necessary to turn the tractor must vectorially be equal to the centrifugal force acting through the center of gravity (Fig. 3).

Since the centrifugal force acting at the center of gravity, or 32 in above the ground, can only be resisted by the forces acting at the surface of the ground, this results in creating an unbalancing or overturning couple. The tractor remains stable and upright only when the line of force of the resultant of the weight and centrifugal force falls inside of the line connecting the outer front and rear wheels.

Evaluating these fundamental formula we are able to draw the curve showing the relation between speed and turning radius at which the tractor becomes unstable. The general-purpose tractor having a rear wheel tread of 84 in is fairly stable. At 10 mph the minimum turning radius is roughly 12 ft. For 20 mph it is 48 ft (Fig. 4). You remember the old rule that centrifugal force varies as the square of the speed. Reducing the rear wheel tread to 56 in (Fig. 5) increases the minimum turning radius for 10 mph from 12 ft to 15 ft, and for 20 mph—well, it will take a half a block to turn around. Those of you who have driven general-purpose tractors at high speed will agree that for turning corners and feeling secure with everything under control, 5 mph is plenty fast. For the sake of simplicity, the analysis has only considered the machine as a free body revolving about a center of rotation. We all know that other forces are acting and occasionally cause further unbalances. The better part of valor is to keep the machine under control by operating at a safe speed.

My conclusions are that increased tempo in farming operations is in the offing. This increase in speed will not be accomplished for speed alone, but improved implements will permit operating at a greater and more economical speed.

Contribution by B. G. Burr

MEMBER A.S.A.E.

TO ME, as a farm operator, high speed means many acres per hour, and before the Society goes too far along with this subject, it might be well to tighten our definition.

A stepping up of acres worked per hour may be obtained in three ways, with a wide rig behind a slow tractor, a narrow rig behind a fast tractor, and two or more narrow tools in tandem behind a relatively slow tractor. You are all familiar with the first type of operation. The second is what we are talking about today, and the third is, on the whole, the most efficient way to perform tillage operations that I know of. Not enough attention has been paid to it at these meetings, but its use is increasing, and it may be that it is because many farmers still distrust high-speed work and are adopting this way of utilizing the increased horsepower available in the modern farm tractor.

There is no good reason why this increased horsepower cannot be used at increased speeds, if tools can be designed

to perform work of a quality at least equal to but not poorer than that obtained at low speeds. Advantages resulting from high speeds will be lower tractor investment and lower labor costs per acre worked. Some disadvantages may be higher implement cost because of greater strength requirements, possible higher fuel costs per acre worked, greater breakage, and less quality in work done because of the disinclination of the operator to stop and make adjustments. Coupled with these is the fact that there will always be wide variations in the speeds at which different operations will be performed. This may lead to trouble if tractors are designed with only enough weight to develop their rated horsepower at 4 mph. Such a tractor would be so light that it would go nowhere if coupled to a load that required full engine horsepower at, say, $2\frac{1}{2}$ mph. A case in point is that of one of the newcomers in the small tractor field. The machine as shipped weighs 1800 lb, but when tested at Nebraska at approximately its maximum horsepower it developed 2146-lb pull, and to do this it had to be loaded with cement, water, iron, and human avoirdupois to make it weigh 3375 lb.

If tractors are engineered on this basis and if special tillage tools are required for them, it will naturally result in making obsolete many dollars worth of existing tools which have not lived their useful life. So far I have not yet heard from farmers in general any great demand for high-speed tillage. In fact, when I mentioned this symposium to the head of a group who manage 100,000 acres or so of farm land, his comment was that there are many problems more important than speed for agricultural engineers to work on. It makes me wonder where this demand for speed comes from. I strongly suspect that a great deal of it comes from sales-minded engineers rather than soils-minded engineers.

SOIL AND CROP CONSIDERATIONS

One thing that I would like to emphasize is that soils and crops are not created for engineers to play with. On the contrary, the agricultural engineer owes his existence to the demands made by soils and crops. For this reason, point of view is all important in soil and crop work. Electrical engineers have a very good expression, which I think orients them automatically in their point of view. When matching a line to a load, a generator to a line, or any two pieces of apparatus together, they speak of the "impedence looking from the line to the load", or the "impedence of the amplifier output viewed from the loud speaker." Undoubtedly this habit of thought keeps many problems constantly in focus and makes their solution easier. The best mechanical analogy that I can think of is pumping water with a hand pump. If we pump too slowly, we don't do much work, but we don't get much water. If we pump too fast, we do a lot of work without proportionate results. There is a best speed, however, when the pump and the pipe look at the arm supplying the power and say "This is the way we like to be treated and we cooperate by giving the most results per unit of effort."

It is not my desire to mix too much metaphysics with physics, but what I am trying to point out is that speed for speed's sake is nothing, if in obtaining it we are mishandling the main object of our considerations, the soil itself. Let us be sure in the matter of speed that we are doing what is right for the soil; lest in dealing with miles per hour, horsepower, draft, and so on, we run head on into what Kipling spoke of back in the nineties, "That other heart-breaking power, the perversity of inanimate things."

Economical speeds for modern rubber-tired tractors are 4 to 6 mph. This increase in speed has challenged the implement manufacturer

Contribution by D. C. Heitshu

MEMBER A.S.A.E.

DESIRABLE rate of travel of farm field equipment is limited by the physical law to the effect that kinetic energy equals one-half of the mass times the square of the velocity. The user must be able to stop the equipment quickly to prevent damage to it or to crops, or sometimes to persons or livestock. He must be able to make small changes in direction quickly for the same reasons. And in many cases he must be able to make numerous short turns on side hills. Possibilities of maintaining or increasing the stability and ease of control of field equipment in spite of increasing speed, are limited by other design considerations such as necessary high clearances and practicable tread widths.

There has been a definite trend toward increasing the ground speed of tractors and decreasing their weight and drawbar pull, but our experience indicates that there is a definite limit to how far this trend can go. In other words, ground speed is only the square root value of its influence on the kinetic energy to be controlled. If some change in design makes possible a substantial increase in the kinetic energy which can be satisfactorily controlled, and this increase is used entirely to permit increased speed, when the larger velocity-squared figure is reduced to its root value, the actual increase in permissible velocity is small. From the standpoints of design limitations and difficulty of control, increases in ground speed are more of an implement than a tractor problem.

Some design changes which may permit further small speed increases include increased use of automatic release hitches, stronger construction, lower centers of gravity, improved control devices, and new types of equipment.

Development of these possibilities is limited by several practical considerations. Cost of the changes, additions, or improvements must be met by the user. Manufacturers need strong indications that their customers will mostly be willing to pay this cost in order to be justified in making the change on their standard equipment.

The ability of the average operator to use increased speed with judgment and safety, so that it is an actual advantage, is a limiting factor. Individual operators differ considerably in the rapidity and accuracy with which they recognize the need of a slight change of direction or other change of operation affecting quality of work; and in the time between the moment when they recognize the need and the moment when they accomplish the desired control. The amount of low-quality work or actual damage which

will be done in this space of time increases with the rate of travel.

Different field operations require different degrees of care and accuracy of control to accomplish the desired result. First cultivation of a crop, for example, requires more accurate control than harrowing or rolling an unplanted field. Availability of high speed may tempt the operator to hurry to get the job done, at the expense of lowering the quality of his work. The lower quality may not always be immediately apparent in plants destroyed or spaces missed. It may be hidden in improper depth of tillage, in roots cut, or in other items which show up only after it is too late to correct the fault.

In addition to the control consideration, most implements will do their best quality of work when moved through or over the ground at some certain rate of travel. In some cases this speed is critical. A small variation either over or under it may cause disproportionate decrease in quality of work or in the efficiency with which it is done. In these cases increased rate of travel is made practicable only by adjustment, modification, or replacement of the implement.

Maximum advantage at minimum cost is the object of farm operations. Rate of travel is one factor influencing both advantage and cost, as indicated. It may easily be increased to a point where the advantage of performing a specific operation decreases, and the cost increases, partially or completely defeating the objective of performing the operation. Spraying, corn picking, and combining are examples of operations in which a critical rate of travel might easily be exceeded.

Before customary rates of travel in field operations can be safely increased to any material extent, engineering analysis must determine optimum and critical rates for specific implements, operations, and combinations of working conditions. Then, where higher rates of ground travel are likely to be more advantageous than other methods of increasing effective use of power and labor, necessary adjustments and modifications of equipment and practices can be indicated, and equipment redesigned if that seems justifiable.

There is no royal road to the solution of an engineering problem. Methods of increasing the rate of travel of tractors and field implements have their disadvantages. Release hitches have their limitations. Stronger materials and construction cost more. Stability must be a compromise

Effective rate of travel is limited in some farm operations by the necessity of frequent stops

with clearance. Increased speed, in the hands of poor operators, means capacity to make more and bigger mistakes. Farmers are often slow to accept new methods and machines, and might be slow to accept those which would make higher speeds feasible. Decreasing the weight of a tractor increases the traction problem.

In spite of these problems, engineers can and will provide tractors and equipment with rates of travel as high as the majority of farmers can use efficiently and with safety, considering the jobs to be done, working conditions, and the personal factor of the operator.

Agricultural and Chemical Engineering Relationships

(Continued from page 164)

standpoint are only one of several factors determining economic feasibility. Raw materials and usefulness of resulting products are among the others.

Present open market sources, practices, grades, and prices of farm products, as developed for present food, feed, and processing uses, fall far short of giving chemical engineers a complete picture of the organic materials from farm sources which are or might be made available for industrial processing. Changes from package to bulk marketing, or vice versa, in type and size of package, and other marketing practices are possible. Steps can be taken toward reducing costs so that prices may be mutually satisfactory to the farmer and the processor, once price requirements are defined and related to quantity, quality, and other requirements.

If we are to actively help increase the effectiveness of use of farm organic resources, we must help chemical engineers appreciate the variety of organic materials potentially available from farm sources. We can help them appreciate the economy of organic synthesis of many commercially important compounds. We can help them realize that we are ready and able to help improve, from their viewpoint, the quality and supply of the organic materials with which some of their work starts, and that there are real possibilities in this direction. We may have to press them for specifications of combinations of physical and chemical properties wanted in raw materials for the processing industries. And we may expect to get our answer, not in terms of U. S. No. 1, or other grades of corn, soybeans, or potatoes, but in terms of degree of saturation of oils, solubility of proteins, fiber dimensions and strengths, and percentages, formulas, and properties of various starches, sugars, alcohols, and organic acids, all at a certain cost per unit of chemical yield.

Then with the help of agricultural scientists we should be able to pick out some likely organic sources of materials with or approaching these desired combinations of properties and, specifically in the field of agricultural engineering, determine the manner and extent to which these properties are influenced by methods of production, harvesting, storage, and handling, as well as possibilities of meeting cost requirements.

This prospect of working with chemical engineers as well as agricultural scientists, to help increase the effective use of farm organic resources, offers a distinct hope for increasing the genuine economic service which can be rendered by farmers, and their consequent rewards. Some agricultural engineers are finding the opportunity to work in this direction, and we expect their results to prove highly significant in shaping the future of farming and of agricultural engineering.

Studies of Barn-Dried Hay

By William E. Hudson

JUNIOR MEMBER A.S.A.E.

DURING the past two summers a barn hay-drying system as devised by the Tennessee Valley Authority has been undergoing tests at the University of Georgia dairy farm. The general purpose of these tests has been to determine the possibilities of using the system under Georgia conditions.

Briefly the system consists of a 5-hp electric motor, a centrifugal type blower and a system of air ducts laid on the mow floor. The air ducts are 8 in high and 10 in wide, spaced approximately 5 ft on centers and extending to within 5 ft of the sides of the mow. By providing a ¾-in space between the lower edge of these ducts and the floor, air flow through the hay was achieved. A central duct built tight to the mow floor fed the air from the blower to the smaller laterals. The hay mow is 37x43 ft in area.

In general, the hay which was to be barn-dried went through the following schedule. Cutting started as soon as the dew was off in the morning, usually about 9:30 am, and continued until the amount cut equaled the amount that could be stored in about a 2 to 3-hr period. After cutting, the hay remained on the ground until about 4:00 pm. To facilitate drying, the hay was windrowed once during this period. Storing started after 4:00 pm and continued until the cut hay was in the barn. None of the hay cured in the barn stayed in the field overnight. In placing the hay in the barn, an effort was made to spread it evenly over the ducts to a depth of not more than 6 ft for one curing period. The amount of green hay put in the ventilated mow in any one afternoon varied from 2 to 10 tons. Two successive cuttings were placed directly on top of the first and a maximum depth of approximately 10 ft was reached.

The field-cured hay which served as a check followed the same procedure with the exception that it was allowed to remain in the field until cured. An effort was made not to discriminate, in selection of barn or field-dried hays, both types being taken from the same field and, where possible, from alternate windrows.

MOISTURE DETERMINATIONS

Since moisture content largely determines the curing stage of hay, a simple, quick, and accurate method for ascertaining this factor was necessary. The Dean and Stark method, whereby moisture could be driven from a hay sample, weighed and compared to the total sample weight within a 20 to 30-min period, proved satisfactory.

Samples for moisture-content analysis were taken from the field at cutting time and from each load just prior to storage. During the curing period additional samples were taken from the stored hay to determine curing progress.

Alfalfa hay of the type studied was found to have a moisture content of 60 to 70 per cent when standing in the field. After being cut and allowed to dry in the field during the day, the moisture content would drop to between 25 and 50 per cent, depending mainly upon weather conditions and length of time exposed. To cure the hay required lowering this moisture to slightly below 20 per cent. This was the task of the drying system.

In starting to fill the mow, the entire first day's cutting was stored before the fan was started. After that, heat was removed from the hay whenever necessary by using the blower. Usually 30 min operation in a 6-hr period was ample. A time switch enabled this phase of the work to be automatic in operation. During periods of low relative humidity during the day, the blower was operated to remove moisture. Weather conditions determined the length of the blowing operation, which varied from about one to more than ten hours per day. A humidistat would start the blower when relative humidity dropped below a desired point, thus drying the hay. When the relative humidity rose above this point the blower would stop. Usually the humidistat allowed an hour or two of operation after 6:30 pm, when storing usually finished. None of the entering air was artificially heated. An integrating kilowatt-hour meter placed in the motor circuit enabled an accurate determination of power consumption. Revelant information such as weather conditions and changes in operating schedules was recorded.

Over a two-year period, approximately 60 tons of alfalfa hay have been cured with an average power consumption of 41.5 kw-hr of electricity per ton. This figure could be lowered to below 40 kw-hr by disregarding the power consumed due to faulty operation and design of the system. Often the majority of the hay was over-dried in an effort to cure small spots where air flow was poor.

COMPARISON OF QUALITY

Samples of both field and barn-cured hay from the first test of 1939 were submitted to the office of W. H. Hosterman, marketing specialist, agricultural marketing service, U. S. Department of Agriculture, for color, grade, and class determination. As a result of this analysis, all samples were classed as mixed hay. The barn-dried samples graded U. S. No. 2, with an average color rating of slightly over 50 per cent. The field-dried samples ran U. S. No. 3, with a color average of less than 20 per cent. Additional samples submitted to the same authority at the end of the 1939 season did not show such uniform difference but did indicate that the barn-dried hay for the season ranged one class better than the field-cured hay. About 45 per cent of this field-dried hay was rained on at least once before it was stored. A marked advantage in color percentage was shown by the barn-cured hay.

A carotene content analysis by Dr. C. A. Cary, acting chief of the division of nutrition and physiology, Bureau of Dairy Industry, U. S. Department of Agriculture, resulted in a value of 40.1 milligrams of carotene per kilogram of barn-dried hay and 8.7 milligram per kilogram for the field-cured hay.

Before the second hay season began, one change was made in the drying system. Harmful heating was experienced directly over the big central air duct, due to improper air distribution. To eliminate the trouble, the lateral ducts were shortened 18 in, lowered to ½ in above the floor at their ends, and raised to 1½ in above the floor next to the central duct. This change was successful in eliminating the difficulty.

Three more cuttings of alfalfa were cured during 1940. Samples of this hay graded not lower than U. S. No. 2, and several samples ran to *(Continued on page 172)*

A paper presented before a meeting of the Southern Section of the American Society of Agricultural Engineers at Atlanta, Ga., February 7, 1941. Author: Instructor in agricultural engineering, University of Georgia.

An Insecticide Dispersing Machine

By C. W. Veach and W. E. McCauley
JUNIOR MEMBER A.S.A.E.

ONE of the many things rural electrification will make possible is better insect control on the farm. One device for this purpose is an insecticide dispersing machine. Up to the present time, fly sprays have been dispersed by means of hand sprayers, compressed-air sprayers, mechanical-blower sprayers, or by means of steam-pressure sprayers often referred to as "steam diffusers".

One serious weakness of these machines is the inability of the dispersing mechanisms to produce a sufficiently small particle size. With such machines, the difficulty of creating and maintaining a sufficient toxic fog of large particle sizes necessitates the continued introduction of fly spray to replace that which has settled out. This action results in the use of more insecticide than is necessary in the case of fogs composed of smaller particles. To compensate for this loss due to settling, and to assist in dispersing the insecticide, a diluting oil or carrier is used. Use of an excess of a diluting oil leads to several further objections. An oily residue is left over all exposed furniture and equipment in the treated areas. Such residue may react with certain types of floor coverings. The oily residue on floors is a serious accident hazard. The use of excess oil means additional cost.

A further disadvantage of mechanical sprayers is that the fly spray must be directed at the flies in order to be most effective. In any case, the type of device to be used for dispersing the fly spray depends upon the accessibility to the flies in their environment.

In practically all cases, fly sprays have consisted of dilute solutions of pyrethrum or of synthetic organic insecticides. In Soap Magazine for June 1940, Sullivan and others, in an article on insecticide dispersion stated "The development of methods for the rapid vaporization or dispersion of relatively nonvolatile insecticides would broaden the range of materials that could be used as fumigants." They reported favorable results obtained by dispersing pyrethrins I and II and rotenone, by spraying a fine mist of these chemicals against a hot plate.

As a consequence of Sullivan's work, it was apparent that the heat in this case did not cause a disintegration of the pyrethrins, as had previously been supposed. As a result of this paper the development of a machine which would provide a more efficient means of volatilizing or dispersing not only pyrethrins, but various synthetic organic insecticides as well, was begun.

The equipment mentioned by Sullivan was cumbersome and required compressed air. Preliminary tests also showed that it resulted in considerable loss of materials due to spattering off the hot plate. Much of the work to date has been the development of a type of machine which will eliminate most of these objections. Fig. 1 shows the latest model in operation. The chief advantages of the machine are as follows: (1) There is a more efficient dispersion of an insecticidal chemical throughout a given space; (2) there is no oily residue left over furniture and equipment because most of the diluting oils, which are necessary when dispersion is accomplished by mechanical spraying, are unnecessary with this type of machine; (3) there is a saving in labor because of the automatic operation of the machine and because of the smaller total amount of solution needed; (4) it is usually unnecessary to move the machine about, because of the complete dispersion of the vapor; and (5) the machine is readily adaptable to various insecticidal chemicals, merely by regulating the temperature of the cylinder.

Smoke emanating from the machine shown in Fig. 1 was produced by lard oil, which was used in making the photograph because of the dense smoke produced. This oil is not used as a carrier in any of the insecticides, but it is interesting to note that such a stable smoke cannot be produced from lard oil by ordinary heating. The vapor resulting from insecticides used in the machine might be described as resembling a fog, the exact color and density varying with different chemicals and rates of application.

The problem of dispersing insecticides in this manner involves two fundamentals: the design of an efficient machine, and the selection of the chemical best adapted for such use and the finding of the optimum temperature associated with that chemical.

In operation, a measured quantity of the insecticide is poured into the feeding mechanism reservoir, the rate of flow of the insecticide being controlled by the needle valve. After passing through the feeding tube, the insecticide is delivered to the rotating distributor which throws it out against the hot cylinder. The high temperature of the hot cylinder causes the insecticide thus delivered to be immediately and efficiently vaporized. The fan carries the vapor upward, prevents small particles of the insecticide from passing out through the bottom of the machine, and aids in maintaining a lower motor temperature. Work on the machine has just begun and several important changes in design are being studied.

Over fifty preliminary insecticide tests were run in a standard Peet-Grady chamber and a number of tests were run in a closed room. In addition to these, twelve tests were run in one of the large round dairy barns on one of the University of Illinois farms as a check on effectiveness of the machine under practical conditions.

Flies used in the barn tests were the wild flies normally found there. There were some biting flies present, but the population was mostly

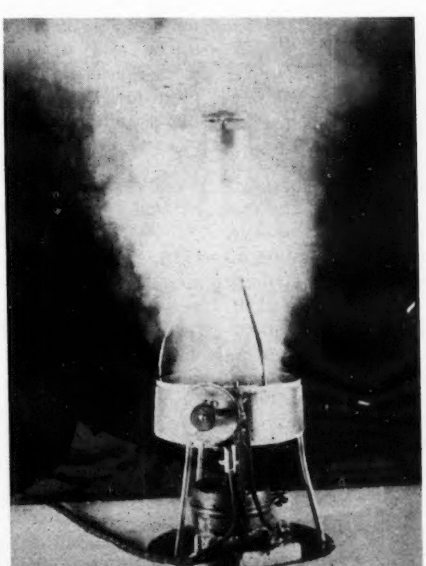


Fig. 1 Fog-producing effect of the insecticide dispersing machine demonstrated with lard oil for convenience in photographing. Insecticide fogs are less dense

Adapted from a paper presented before the Rural Electric Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 6, 1940. Authors: Respectively, research assistant in agricultural engineering, University of Illinois, and assistant entomologist, Illinois State Natural History Survey.

house flies, which species is the most difficult to kill. In most cases the flies were so thick that they covered wires hanging from the ceiling. The part of the barn which was used has a volume of about 35,000 cu ft. When drafts were not present at the time of the test, favorable results were secured without moving the machine about the barn. In only one case were the drafts so bad that it was necessary to move the machine in order to secure a complete knockdown. In these tests it was necessary only to close the doors and windows, and to close large openings such as the feed chutes and trap doors. Other than this there was no special preparation to make the barn airtight. In those tests in which there was a considerable draft, it was noticed that the flies near drafty areas were not as effectively knocked down as those in the areas where there were no drafts.

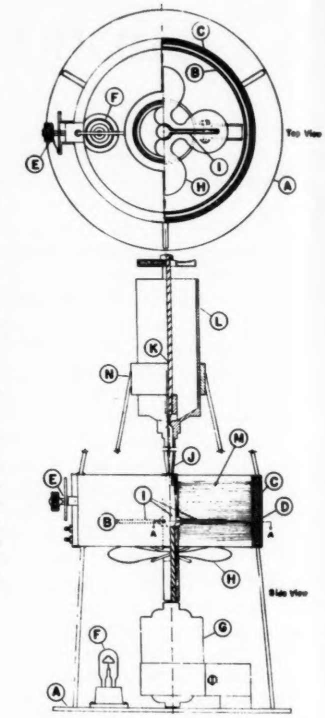
Results of tests in the barn showed that Lethane 384 was the most economical of the common chemicals used. As a result of the tests we can definitely say that Lethane 384 will give 99 plus per cent knockdown when used at the rate of $7\frac{1}{2}$ cc per 1,000 cu ft, and dispersed by this machine. With Lethane 384 priced at $4.00 per gal, this means a cost of 28 cents for sufficient material to knock down practically 100 per cent of the flies in a room of about 35,000 cu ft capacity.

In a Peet-Grady chamber, the use of a petroleum solution, by weight $1\frac{1}{4}$ per cent pyrethrins I and II ($\frac{1}{2}$-hr exposure), resulted in 85 per cent knockdown at the end of 10 min, 100 per cent knockdown in $1\frac{1}{2}$ hr, and 95 per cent kill in 24 hr. More promising than this was the use of Lethane 384, in which case 2 cc were used ($\frac{1}{2}$-hr exposure), resulting in 100 per cent knockdown in $3\frac{1}{2}$ min and an average mortality of 81.4 per cent within 19 to 24 hr. None of the chemicals, when vaporized by use of this type of apparatus, left any oily residue over the equipment. There are other chemicals which have shown even more promise than the Lethane 384 from the standpoint of kill, but they have been developed by a private manufacturer, and the chemicals used cannot be disclosed here.

One of the biggest potential uses of this type of equipment is in the control of flies in dairy barns and milk houses. The advantages of the ease of killing flies and of having the cows remain quiet while being milked, are sufficient to warrant its use. Tests conducted in various places have shown that the fly sprays applied on cattle with mechanical sprayers tend to decrease milk production. This objection, as well as the cost and labor involved, seriously limits the use of mechanical sprayers. Cattle have been subjected to the chemicals dispersed with this unit with no noticeable discomfort. For use in screened dairy barns it should not be necessary to kill the flies more than once every day or two. Swishes and a fan installed at the entrance would brush the flies off as the cows enter, and thus maintain a fairly low fly population inside a screened barn.

Since many modern public buildings have air-cooling and circulating systems, it would be a simple matter to introduce the vapor into the system, kill the flies, and then exhaust the air again with a minimum of inconvenience. Diluting oils commonly used in fly sprays to be dispersed by mechanical sprayers, react with and damage the asphalt-base table and floor coverings used in many such buildings. For this reason, mechanical sprayers of insecticides cannot be consistently and safely used in many such buildings, whereas there is no such objection to our type of equipment.

Of the chemicals mentioned, none were noticeably injurious. Nevertheless, in most cases, it will be advisable to use the insecticide when no one is present. The automatic nature of this machine makes it quite practical. Although it is possible to work in the room with the vapor



CONSTRUCTION OF THE INSECTICIDE DISPERSING MACHINE

A, base of the machine; B, a metallic cylindrical hot plate; C, an electrical resistance coil for heating the hot plate; D, insulation on the outside of the cylindrical hot-plate; E, an adjustable thermostat for controlling the temperature of the hot plate; F, a pilot light for indicating operation of the thermostat; G, a motor for driving the fan and the insecticide distributor; H, a fan blade; I, an insecticide distributor; J, feeding tube; K, a needle valve of the feeding mechanism; L, reservoir of the feeding mechanism; M, grooves on the inside of the cylindrical hot plate, and N, feeding mechanism support

present, most people will prefer to wait until the vapor has been cleared out. In dairy barns, milk houses, and public buildings there is plenty of time when treatment can be made.

While killing flies with pyrethrum in a small room, it was discovered that the vapor had also killed box-elder bugs which happened to be in the room at that time. This is especially significant since box-elder bugs are extremely difficult to kill. On another occasion, the machine was placed beneath a card table at an outdoor party, and by using ten cents worth of material in the machine, the mosquitoes were kept away for about 3 hr. This was done in the fall of 1940, when mosquitoes were extremely annoying.

While only a comparatively small amount of work has been done with this type of equipment, it clearly indicates the possibilities in the field of dispersing insecticides as vapors.

Studies of Barn-Dried Hay

(Continued from page 170)

U. S. No. 1. For class, the samples ranged from a low of mixed hay to extra-leafy alfalfa. The hay cured during the second season was, in general, better than that of the first year. Color of the samples submitted averaged 58 per cent, and carotene content 84.1 milligrams per kilogram. Unfortunately, no samples of comparative field-cured hay were secured, due mainly to the fact that it was necessary to feed this hay almost immediately after it was cut. However, a rough visual inspection was made by an agent of the U.S.D.A. Agricultural Marketing Service. As a result of this inspection, the field-cured hay was classed rather uniformly as U. S. No. 3 mixed hay. About 20 per cent of it had been rained on during the field-curing period.

Although the study is at present incomplete, it is recognized that results this far obtained are distinctly favorable and that the barn-drying method has merit.

Interpretation of Soil Conservation Data for Field Use

By Dwight D. Smith
MEMBER A.S.A.E.

FACTORS which affect soil loss and runoff may be divided into two broad classes, including those factors which for a given farm cannot be varied, and those factors which may be manipulated so as to vary the rate of soil and water loss. An outline grouping of these factors follows:

- I Uncontrollable Variables
  - A Climate
    - 1 Rainfall: (a) amount, (b) intensity, (c) frequency, (d) distribution
    - 2 Temperature
    - 3 Wind
    - 4 Humidity
    - 5 Sunshine
  - B Physical features
    - 1 Soil type
    - 2 Degree of slope
    - 3 Degree of erosion
- II Controllable Variables
  - A Physical and chemical features
    - 1 Fertility
    - 2 Condition of soil
    - 3 Length of slope
    - 4 Soil moisture
    - 5 Infiltration capacity
  - B Conservation features (by which factors of II, A are controlled)
    - 1 Vegetation: (a) individual crop, (b) crop sequence, (c) surface cover
    - 2 Soil treatment: (a) lime, (b) commercial fertilizer, (c) crop residues (including green manure), (d) manure
    - 3 Mechanical practices: (a) contouring, (b) strip cropping, (c) terracing, (d) outlet, waterway, and gully control

Soil conservation and other experiment stations have studied these variables and have established certain relationships for a number of specific soils. While the data are by no means complete, their use when tempered by practical experience has resulted in greatly improved systems of conservation farming. Coordination of available data should make the problem of application simpler and more definite, and point out the factors requiring additional research.

METHOD OF EXTENDING PLOT DATA FOR FIELD USE

Mathematical formulas have been used in practically all design work. Early formulas were largely empirical, and, as additional knowledge was gained, they have been modified or replaced by theoretical relationships. Design formulas, even though empirical, should be of assistance to soil conservationists, particularly to the inexperienced technician, in making more correct field applications. As additional knowledge is gained, these formulas may be expanded and corrected where necessary.

Experimental plots must be small because of physical and financial limitations, if an adequate range of crops, treatments, etc, is to be studied. Data secured from such plots may be extrapolated for field use by modification of an empirical equation[1]* expressing the relationship between degree and length of slope and soil loss as follows:

$$A = CS^{7/5} L^{3/5}$$

A = average soil loss in tons per acre
S = degree of land slope
L = length of land slope
C = a constant of variation which combines the effect of weather, soil, crops, or rotation, and treatment[2].

As the values of A, S, and L are known for a given plot over a given period of time, the value of C may be determined. If the plots are operated up and down hill, and the equation is to be used in making field applications involving mechanical practices, a factor must be introduced into the equation to provide for the effect of the practices. If the soil loss with a given practice is expressed as A_1, then $A_1 = AP$, in which P is the ratio of A_1/A. Then

$$A_1/P = CS^{7/5} L^{3/5}, \text{ or } L = \left(\frac{A_1}{PC}\right)^{5/3} S^{-7/3}$$

This equation will give the maximum length of slope allowable for given values of C, S, A_1, and P, and is the formula used in preparing Figs. 1 to 4, inclusive. Data used are mainly from plot series 1, 2, 5, and 15 on Shelby soil, both surface and desurfaced, at the soil conservation experiment station, Bethany, Mo.

In the use of the data presented and discussed here, it must be remembered that the data cover a limited period of time, and, therefore, the climate variable may not have been sampled adequately. This is particularly true with respect to the effectiveness of the mechanical practices. Also the experiments are not sufficiently complete to enable a final solution. It is thought that the value of the individual factors as assigned here will show more change with additional data than will their relative values. However, it is felt that the principles presented are sound and that the material will be of assistance in applying available data toward a more adequate solution of the soil conservation problem.

EVALUATION OF FACTOR C

For a given soil, degree of erosion, and climate, the value of C can be varied by the rotation and soil treatment used. The following sets of conditions were evaluated:

1 Shelby surface soil without soil treatment: (a) Corn, wheat, clover, and timothy (Fig. 1); (b) corn, oats, clover and timothy, timothy (Fig. 4).

2 Shelby subsoil: (a) Corn, oats, clover and timothy, timothy, without soil treatment (Fig. 2); (b) corn, oats, clover and timothy, timothy, with soil treatment** (Fig. 3).

A paper presented before the Soil and Water Conservation Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 5, 1940, based on cooperative research by the Missouri Agricultural Experiment Station and the research division of the Soil Conservation Service, U. S. Department of Agriculture. Author: Project supervisor, U.S.D.A. Soil Conservation Experiment Stations (Columbia, Mo.)

*Superscript figures indicate references cited at the end of this paper.

**This and subsequent reference to soil treatment refers to the application of agricultural lime and phosphate fertilizer.

The value of C for the 3-yr rotation of corn, wheat, clover and timothy, on Shelby surface soil should represent a fair sampling of the weather variable, as the data are for a 9-yr period with each crop of the rotation represented each year. A separate set of curves is not shown for this rotation with soil treatment because the average soil loss from a single plot with soil treatment showed only a 6 per cent reduction in soil loss for the 9-yr period.

The available data for the 4-yr rotation were 8-yr average soil losses for each of the three conditions, but with only one crop of the rotation represented each year. By comparing the average soil loss of the crops of the 3-yr rotation for the years corresponding to those of the same type crop in the 4-yr rotation, with the complete data for the 3-yr rotation, it was determined that the soil loss for the more complete sampling of the weather variable was 71 per cent of that for the available data of the 4-yr rotation. Adjustments of the 4-yr rotation data were made accordingly. Because of this necessity for correcting the soil loss averages to secure comparable values of C, no other conditions were evaluated.

EVALUATION OF FACTOR A_1

A_1 in this case is considered a constant, as a maximum rate of soil loss of 4 tons per acre per year has been assumed. Four tons of soil loss per acre per year is equivalent to 250 yr to erode the surface 7 in, or an average annual rate of less than 0.03 surface inch.

Actually the value of A_1 should be based upon that rate of soil loss which will permit at least a constant or preferably an increasing time gradient of soil fertility. Thus the value of A_1 will not be constant, but will vary with the type of soil treatment, other factors being constant. Unpublished data[3] from the Bethany station indicate that the fertility factor was increasing slightly on a plot in a 3-yr rotation of corn, wheat, and meadow with soil treatment, and which had a loss of approximately 4 tons per acre per year. The fertility was decreasing on a plot having the same rotation but without soil treatment, which had approximately 5 tons of soil loss per acre per year.

Four tons soil loss per acre per year may be too great a loss for maintenance of soil fertility on treated Shelby surface soil when erosion has progressed to the point that plowing is diluting the surface soil with thin layers of subsoil. However, the rate of loss may be even greater than 4 tons per acre per year and fertility be maintained, as chemical analysis has shown larger concentrations of certain nutrients in Shelby subsoil than in the surface soil. The main deficiency of the subsoil is organic matter. Thus a gradual dilution of surface soil with subsoil, if at a slow enough rate, when coupled with the organic matter added by cropping, could even be of benefit. Detailed chemical studies of the soil profile with other related investigations would be necessary to answer the question definitely. Undoubtedly a fertility storage concept similar to the storage equation of hydraulics would be involved.

EVALUATION OF FACTOR P

The factor P, the ratio of soil loss with a mechanical conservation practice to the soil loss without the practice, has been considered a constant in the equation for a given practice, because sufficient data were not available to indicate the presence or direction of a trend with other variables such as slope and crop.

Contouring. A comparison of 4 yr data from two 270-ft plots on the Bethany station, after adjustments for rotation and degree of slope, indicates that the soil loss from contouring is 57 per cent of that from up-and-down-hill operation. Data concerning contouring from other stations[4,5] as well as from Bethany, indicate that a wide variation may be expected from contouring, depending largely upon the amount and intensity of rainfall. Apparently the value of contouring decreases with increased amount and rate of rainfall, but fortunately the frequency of occurrence of rainfall decreases with increased amount and rate. Thus any factor expressing the relative value of contouring must be based upon a long time average, to insure a sufficient sampling of the weather variable.

Rotation Strip Cropping. A comparison of 4 yr data from six plots 270 ft long, three of which are contoured and cropped to a 3-yr rotation of corn, wheat, meadow, and the other three rotation-strip-cropped with the same rotation, indicates that the soil loss from strip cropping is 44 per cent of that from contouring, and 25 per cent of that from up-and-down-hill operation. The effectiveness of rotation strip cropping depends upon the quality of the meadow strip. If the fertility of the soil is deficient, or adverse seasons prevent establishment of the meadow, any expected benefits[4,5,6,7,8] may be eliminated completely.

Terracing. Theoretically, the effectiveness of terracing depends upon the length of slope of the field terraced, the effectiveness increasing as the length of slope increases. Terraces or diversions are the only conservation practice applicable to cultivated land which decreases the length of slope. This is the major justification for terracing. At the Bethany station, four cultivated watersheds on which three different mechanical conservation practices were applied have been under measurement for soil and water loss since 1934. During these years there has been a deficiency of rainfall, and consequently the soil loss is considered to have been below normal. The value of P determined from these data for terraces is 0.03; the soil loss from the field after terracing with contouring was 3 per cent of that from up-and-down-

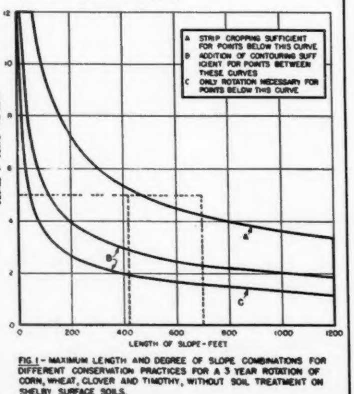


FIG. 1 - MAXIMUM LENGTH AND DEGREE OF SLOPE COMBINATIONS FOR DIFFERENT CONSERVATION PRACTICES FOR A 3 YEAR ROTATION OF CORN, WHEAT, CLOVER AND TIMOTHY, WITHOUT SOIL TREATMENT ON SHELBY SURFACE SOILS.

SOIL CONSERVATION EXPERIMENT STATION
BETHANY, MISSOURI

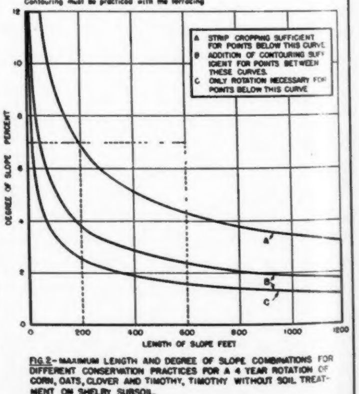


FIG. 2 - MAXIMUM LENGTH AND DEGREE OF SLOPE COMBINATIONS FOR DIFFERENT CONSERVATION PRACTICES FOR A 4 YEAR ROTATION OF CORN, OATS, CLOVER AND TIMOTHY, TIMOTHY WITHOUT SOIL TREATMENT ON SHELBY SUBSOIL.

SOIL CONSERVATION EXPERIMENT STATION
BETHANY, MISSOURI

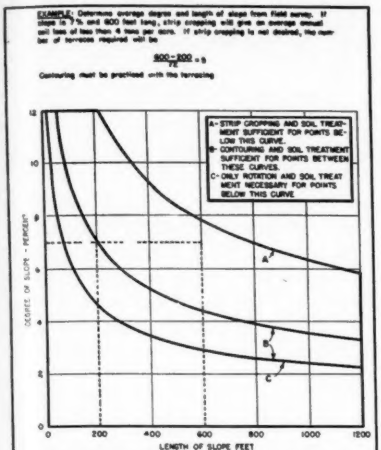


FIG. 3—MAXIMUM LENGTH AND DEGREE OF SLOPE COMBINATIONS FOR DIFFERENT CONSERVATION PRACTICES FOR A 4 YEAR ROTATION OF CORN, OATS CLOVER AND TIMOTHY, TIMOTHY WITH SOIL TREATMENT ON SHELBY SUBSOIL

SOIL CONSERVATION EXPERIMENT STATION BETHANY, MISSOURI

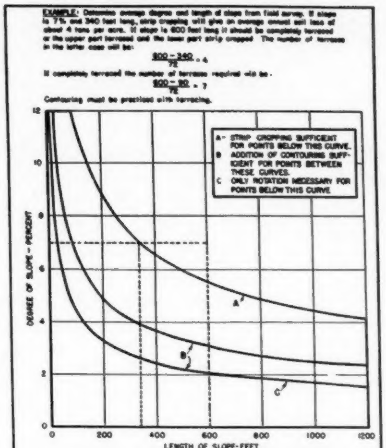


FIG. 4—MAXIMUM LENGTH AND DEGREE OF SLOPE COMBINATIONS FOR DIFFERENT CONSERVATION PRACTICES FOR A 4 YEAR ROTATION OF CORN, OATS, CLOVER AND TIMOTHY, TIMOTHY WITHOUT SOIL TREATMENT ON SHELBY SURFACE SOIL.

SOIL CONSERVATION EXPERIMENT STATION BETHANY, MISSOURI

hill operation with the same rotation and soil treatment. The original length of slope of the field was 700 ft.

Further use of the equation under discussion shows that soil movement to the terrace channel would be 23 per cent of that without a mechanical conservation practice. If 3 per cent is lost from the terrace channel, then 20 per cent remains as deposited silt in the channel until the field is plowed. With one-way plowing, in which all furrow slices are thrown up hill, this deposited soil is moved up the slope, resulting in a net loss to the field of only 3 per cent of the soil which would normally be lost if no mechanical conservation practices were used. In this case, 3 per cent is 0.37 ton per acre per year, and 20 per cent is 2.5 tons. One uphill plowing is equivalent to moving 13 tons of soil per acre to the top of the terrace ridge above[8]. Plowing in this manner more than compensates for the down slope movement of soil and has eliminated the need for terrace maintenance.

USE OF CURVES, FIGS. 1 TO 4, INCLUSIVE

Some of the questions often asked by conservationists, which prompted the development of these curves, were: How far can one go with the more economical conservation practices of contouring and strip cropping on a field of a given slope, and yet secure adequate control? Should available money be spent for soil treatments or mechanical control on an eroded field if there is only enough money for one method? To what extent can the use of mechanical conservation practices be reduced by prolonging the number of years of meadow in a rotation?

Fig. 1 shows that a rotation with one year of meadow is not sufficient for the average slope of the Shelby soils region, unless supported by terracing or strip cropping. As strip cropping is suitable for only the shorter slopes, terracing should be used widely with this rotation, or the upper part of the slope terraced and the lower part strip-cropped. The maximum length of slope for the strip-cropped area may be determined from Fig. 1 after the average length and degree of slope of the field have been determined. The number of terraces required may then be computed.

The soil loss for a rotation with 4 yr of meadow and soil treatment on Shelby surface soil was estimated from the data of the shorter term rotation. A set of curves was not drawn from this estimate, because they would have been nearly the same as the curves of Fig. 3. While this would indicate adequate control, the farmer would probably find the rotation impractical and prefer the shorter term rotation with terracing.

A comparison of Figs. 2 and 3 shows that for a 4-yr rotation on severely eroded land about the same results can be obtained by use of strip cropping with soil treatment as with terracing without the soil treatment, on the average slopes of this soil region. The practical decision should be obvious.

Specific examples for the use of the curves are given on each figure.

SUMMARY

1 An equation has been given which provides for the effect of soil-climate-crop-treatment, length and degree of slope, and mechanical conservation practices on soil loss.

2 A soil loss of not more than 4 tons per acre per year is suggested as a rate which would allow maintenance of fertility with recommended cropping practices.

3 Soil treatments are of extreme importance on Shelby subsoil and of little importance on Shelby surface soil, from a soil loss standpoint.

4 Prolonging meadow in a rotation makes possible the use of less expensive conservation practices.

5 Strip cropping and terracing are necessary supporting conservation practices, in addition to contouring, on the majority of Shelby soils which are to be cultivated.

6 The soil loss from contouring is estimated to be 57 per cent of that from up-and-down-hill operation.

7 The soil loss from rotation strip cropping is estimated to be 25 per cent of that from up-and-down-hill operation.

8 The soil loss from terracing (with contouring and uphill plowing) is estimated to be 3 per cent of that from up-and-down-hill operation.

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Use of CO_2 in the Control of Hay Mow Fires

By L. G. Keeney
ASSOCIATE A.S.A.E.

THE 1940 report of the associate A.S.A.E. Committee on Farm Fire Prevention and Protection of the American Society of Agricultural Engineers included a request for special attention to the possible use of CO_2 (carbon dioxide) as a means of smothering hay and grain fires in early stages. As spontaneous ignition of hay is a leading cause of barn fires in agricultural states, this possibility of control seemed to justify some attention.

Spontaneous heating and ignition of hay is one of the most elusive of fire waste causes, as actual cases are rarely reported until after fire has either reached an advanced stage or resulted in complete loss. It is difficult to simulate actual conditions of overheating for the purpose of experimentation; therefore, the only possibility of testing the efficiency of CO_2 rested in the chance that an actual case would be reported in time for a test to be made.

Early on the morning of July 31 we received a telephone call from a county agent who stated that a barn in his county was in grave danger from overheated hay. The tenant on the farm noticed a strong odor coming from the barn at the time he started the morning feeding. After going into the mow, he noticed that vapor was pouring from a flue in the highest level of the hay. The barn was of frame construction, 42x70 ft. The mow extended to the ground level in the center and was flanked by a 12-ft feeding space on all sides. Of the 150 tons of chopped hay contained in the mow, a few loads of alfalfa had been put in early in June, and the balance, all clover, had been chopped during the first week in July.

Our first undertaking after arriving at the scene was to check all parts of the mow in an effort to establish boundaries of the section which appeared to be heating. Planks were laid on the hay to guard against mishap in case burning pockets were discovered. Preliminary temperature tests were made by forcing a ½-in round steel rod into the hay at 10-ft intervals. The rod was first inserted vertically, and was examined for signs of heating after each test. The hottest hay was found to be within a space approximately 10 by 14 ft. After the heated area was localized, the test rod was inserted horizontally at different distances from the ground, to determine the level at which the temperature reached a maximum. The hay near the ground was cool, and signs of excessive heat were not evident until the rod was inserted about 10 ft above the ground level, or 12 ft below the highest part of the hay.

A thermometer was lowered through 1-in gas pipes which had been driven into the heated hay. A Taylor thermometer equipped with a metal guard and with a temperature range from zero to 230 F (degrees Fahrenheit) was used. Inexpensive dairy thermometers may be used for this purpose, and they are available at most drug stores. The mercury, maximum-registering thermometer appears to be superior to the cheaper types, however, as the readings on the less expensive instruments may drop considerably while being pulled from the pipe.

Temperature readings taken soon after noon ranged from 180 to 190 F. As most authorities agree that the hay should be removed as soon as the temperature reaches 190 F, plans were made for removing the hay from the heated section. The highest reading taken in the afternoon exceeded 230 F.

A serious problem arose when the decision was made to remove the hay. The wide space around the sides of the barn above the feeding space was well filled with dry hay. To move the heated hay conveniently it was necessary to cut a hole in the ceiling over the feeding space, and several loads of dry hay had to be moved before this could be done. It was also necessary to call a local fire truck and to lay 500 ft of hose from the water supply. The use of carbon dioxide became valuable in holding the temperature down during the 5 hr which were necessary for preparation to remove the hay.

Three 1-in pipes were put down in the heated area in spots where the temperature readings were highest. The equipment consisted of several 20-lb drums of CO_2, a Smith pressure regulating valve, and 50 ft of ⅝-in hose, 5/6-in inside measurement. The drums of CO_2 and the control valve were obtained from a local creamery. The hose was placed alternately in the three pipes and it was found that each application reduced the temperature in the vicinity of the pipe about 100 F. The hose was changed from one pipe to another at 20-min intervals and thus the temperature was kept well below the danger point. These applications were begun about noon and were continued until 5:00 p.m.

The fire truck equipment was finally assembled at about 5:00 p.m. and removal of the hay began. Glowing embers were noticed soon after the first 3 or 4 ft of hay were removed. There was occasionally sufficient heat to cause a small blaze. A fire hose was played on the heated area as needed to keep the fire under control. Fire and water damage was limited to the few tons of hay removed from the heated section of the mow.

A contribution of the American Society of Agricultural Engineers Committee on Farm Fire Prevention and Protection. Author: Field supervisor, Farmers Mutual Reinsurance Association.

Customer Satisfaction in Load Building

TO develop increased use of electricity on our rural lines, we rely on customer satisfaction to guide us in planning our activities, J. B. Stere told the rural sales section, annual sales conference, Edison Electric Institute, held recently in Chicago.

Using poultry equipment as an example of the way in which his company performs this function, Mr. Stere described the information furnished to farmers on this equipment. Factual data on operating costs of electric brooders, obtained from closely supervised tests on farms in the company territory, and methods of correcting excess moisture conditions that accompany some installations, are among the material supplied to brooder users and prospects. Sales have been quick to respond to this method of promotion, Mr. Stere pointed out, citing sales of 1,331 brooders in 1940 among the company's 12,000 farm customers.

In satisfying customer desire, Mr. Stere said, the company's representatives are glad to assist customers in locating and correcting any operating difficulties that may arise in their use of brooders or other equipment. While the company does not merchandise appliances, the representatives will take into consideration the construction of the equipment customers buy and advise the conditions that are necessary for successful operation.

Results of Row Spacing Experiments with Corn

By Edgar V. Collins and C. K. Shedd
MEMBER A.S.A.E. FELLOW A.S.A.E.

GROWING corn in 21x21-in check rows was first proposed on the theory that a better final distribution of plants would result, after a normal expected loss of 20 to 25 per cent of the stand. Missing hills in 42x42-in checked corn represent an appreciable reduction in yield, while a missing stalk in 21x21-in rows leaves a space no larger than in 42-in checked corn with a perfect stand. In 1932, a 20-acre field was planted with 21-in check spacing. This corn yielded about 20 bu per acre more than other corn on the same farm, and led to the series of replicated tests reported in Table 1.

In 1933, two spacings, 21-in and 42-in checks, were used, and indicated a 21 per cent yield advantage for the 21-in spacing.

In 1934, a 30-in, two-kernel spacing was added to try to get the same yield advantage with less inconvenience. Extreme drought caused a low yield, and the 21-in spacing gave the poorest results.

In 1935, the 21-in checked plots gave a 26 per cent increase in yield over the 42-in, and the 30-in spacing gave less than half as much advantage.

In 1936, another drought year, differences were smaller but in the same order.

In 1937, two more spacings were added, 30x15-in, single-kernel and 42x10½-in, single-kernel. The 21-in spacing gave the best yield but the 30x30-in was very close.

In 1938, a 42x21-in, two-kernel spacing was added to the experiment and gave next to the highest yield.

In 1939, the 21-in and 30-in spacings were all high, and all 42-in spacings low.

Average final stand for the 21-in spacing is highest. The 30-in spaced rows have the next highest stand, and the 42-in rows the lowest stand.

In 1940, to compensate for this stand difference, two more spacings were added to the experiment—a 30x27-in, two-kernel planting and a 42x42-in with four and five kernels alternating. Both of these spacings gave final stands close to that of the 21-in spacing and the 30x27-in spacing gave yields close to that of the 21-in spacing. In three of the six replications in this year's tests, the 30x37-in spacing gave the highest yields. This gives some encouragement in the effort to get maximum yields without going all the way to the 21-in rows.

In these tests all plots were planted and cultivated with machines. The planters used were a standard four-row, 42-in and two special planters made up of the same units, furnished by Deere and Mansur. The 21-in planter was a six-row, and the 30-in, a four-row unit.

In the center section of Table 1, yields and stands are averaged for different periods. The 8-yr average applies to the 21x21-in and 42x42-in spacings. The 7-yr average includes three spacings; the 4-yr, five spacings; and the 3-yr, six spacings.

In the lower section, yield advantages in bushels and per cent are given for each spacing, compared to the 42x42-in, four-kernel spacing. It will be noted that the yield advantage of the 21-in spacing is quite consistent, and that the 30-in spacing gives approximately half as much yield advantage. The various 42-in spacings gave no significant differences.

A question came up as to whether the 21x21-in spacing was the optimum spacing for single-kernel hills, so in 1936 another experiment was started in cooperation with the Bureau of Plant Industry, U. S. Department of Agriculture. In this experiment the corn was hand-planted and hand-cultivated.

The results are shown in Table 2 for four rates of planting in 21-in rows and a 42x42-in, four-kernel planting giving the same number of plants an acre as the 21x21-in single-kernel planting.

In 1936 drought caused low yields and the thinner spacings did best. In 1937, high yields were obtained and some of the thicker spacings gave best results. The 4-yr average, however, indicates an advantage for the 21x21-in spacing for each hybrid used in the experiment, as compared to other spacings tried.

It will be noted that while yield differences favor the 21x21-in single-kernel spacing, as compared to the 42x42-in hill spacing, the differences are less than were secured in the experiments with machine-planted and cultivated corn. This may be due to that fact that somewhat better final stands were secured with the hand-planted and cultivated experiment.

EQUIPMENT FOR GROWING CLOSER SPACED CORN

Planters. Standard two-row, check-row planters may be adjusted down to a 28-in row spacing. Standard four-row beet and bean drills can be set for closer spacings. It is our opinion that

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Authors: Respectively, research professor of agricultural engineering, Iowa Agricultural Experiment Station, and agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

TABLE 1. SUMMARY OF CORN SPACING EXPERIMENTS CONDUCTED COOPERATIVELY BY THE AGRICULTURAL ENGINEERING SECTION OF THE IOWA AGRICULTURAL EXPERIMENT STATION AND THE U. S. BUREAU OF AGRICULTURAL CHEMISTRY AND ENGINEERING

			21x21-in, single kernel		30x30-in, two kernels		30x15-in, single kernel		30x27-in, two kernels		42x42-in, four kernels		42x21-in, two kernels		42x10½-in, single kernel		42x42-in, four and five alternating	
Year	Hybrid	No. of replications	Stand, plants per acre	Yield, bu	Stand, plants per acre	Yield, bu	Stand, plants per acre	Yield bu	Stand, plants per acre	Yield, bu	Stand, plants per acre	Yield, bu	Stand, plants per acre	Yield, bu	Stand, plants per acre	Yield, bu	Stand, plants per acre	Yield, bu
1933	Ia. 931	2		93.1								76.7						
1934	Ia. 942	5	9,332	8.1	10,868	11.4					8,226	12.1						
1935	Ia. 942	5	10,348	74.2	10,058	63.9					9,804	58.7						
1936	Ia. 942	10	12.312	31.9	12,230	31.1					12,350	29.4						
1937	Ia. 939	9	12,083	82.9	11,126	81.2	11,446	77.0			11,329	75.3			10,486	77.8		
1938	Ia. 939	7	12,031	90.6	9,787	79.1	11,026	83.6			10,829	82.8	10,657	85.9	9,704	80.5		
1939	Ia. 939	6	12,373	73.1	11,233	73.0	11,288	71.7			9,925	59.6	10,368	63.5	9,605	61.8		
1940	Ia. 939	6	12,550	91.5	11,950	86.0	11,880	87.5	12,650	89.5	11,550	84.0	11,320	83.2	11,550	82.6	12,850	84.2
8-yr average	1933-40			68.2								59.7						
7-yr average	1934-40		12,259	64.6	11,036	60.8					10,573	57.4						
4-yr average	1937-40		11,576	84.5	11,024	79.8	11,410	80.0			10,908	75.4			10,336	75.7		
3-yr average	1938-40		12,318	85.1	10,990	79.4	11,398	80.9			10,768	75.5	10,782	77.5	10,286	75.0		
Yield advantages over 42x42-in spacing			per cent	bu	per cent	bu	per cent	bu	per cent	bu	per cent	bu	per cent	bu	per cent	bu	per cent	bu
8-yr average	1933-40		14.2	8.5														
7-yr average	1934-40		12.6	7.2	5.9	3.4												
4-yr average	1937-40		12.0	9.1	5.8	4.4	6.1	4.6							0.4	0.3		
3-yr average	1938-40		12.7	9.6	5.2	3.9	7.2	5.4					2.6	2.0	–0.7	–0.5		
1-yr average	1940		8.9	7.5	2.4	2.0	4.2	3.5	6.6	5.5			–1.0	–0.8	–1.7	–1.4	0.2	0.2
Perfect stand for each spacing, plants per acre			14,224		13,939		13,939		15,488		14,224		14,224		14,224		16,002	

if closer row spacings are used extensively, drilling will be more popular than checking or hill dropping. A drill is simpler and can be operated much faster. A 21-in check-row planter should be operated at about one-half the speed of a 42-in planter. Improved technique for cultivating appears to give satisfactory weed control in drilled corn and avoids the bouncing of rubber tires in crossing the rows.

Cultivation. Two cultivations appear to be enough for either 21-in or 30-in row spacings. The last cultivation can be given with a cultivator having only 18 in of clearance. This means that, with the tractor cultivator, it is only necessary to get the shanks and sweeps in suitable positions without regard to the location of the beams or cross-arms, because these will be above the corn and will not interfere.

Corn Pickers. The two-row corn picker is a real influence for the standardization of rows to a 40 or 42-in spacing. Single row pickers will handle rows as close as 30 in, but that is about the limit with machines in production.

It has been observed that under some conditions pickers have difficulty in harvesting yields above 90 bu per acre. Reducing the row spacing should be a satisfactory remedy. A yield of 100 bu per acre with 30-in row spacing would have the same amount of corn per unit row length as a yield of 70 bu with a 42-in spacing. A special machine would be required for 21-in rows, and it is probable that it should be at least a two-row unit.

Disposal of Crop Residues. If it is desired to disk in or plow under the corn stalks in the spring, a 21x21-in spacing would seem to be an ideal arrangement, on account of the better distribution of stalks and roots over the ground.

CONCLUSIONS

1 Higher yield of corn may be expected with closer row spacings, the optimum being single-stalk hills evenly spaced, with a planting rate suitable for the conditions encountered.

2 A 21-in row spacing would require a tractor which can be adjusted to fit 21-in rows, a special planter, and a special harvesting machine.

3 A 30-in row spacing would give some increase in yield, the needed equipment is available, but the user would be limited to a single-row picker.

4 A row spacing between 42 in and 30 in has not been included in these experiments, and there is little encouragement in the results presented to expect that the increased yield which might be obtained would be large enough to warrant a change. However, if a corn grower is using three-kernel hills in 42-in checks he should expect an increased yield by changing to three-kernel hills checked 36x36 in, under conditions similar to those under which these tests were made.

TABLE 2. YIELD RESULTS OF SPACING EXPERIMENTS COOPERATIVELY WITH THE U. S. BUREAU OF PLANT INDUSTRY FOR THREE COMMERCIAL CORN HYBRIDS AND INCLUDING ONLY COMPARISONS CARRIED ON 3 OR 4 YEARS

(Figures represent bushels per acre)

Year of test	Hybrid	21x 29.4-in, single kernel	21x 21-in, single kernel	21x 18.375-in, single kernel	21x 14.7-in, single kernel	42x 42-in, four kernels
1936	Ia 939	48.6	40.8	37.4	35.2	39.6
1937	Ia 939	94.0	104.5	108.4	107.7	102.5
1938	Ia 939	76.5	91.9	70.0	66.1	79.9
1939	Ia 939	79.1	97.3	87.3	94.8	84.2
Totals		298.2	334.5	303.1	303.8	306.2
4 yr ave		74.6	83.6	75.8	76.0	76.6
			7.0 bu, or 9.2 per cent yield advantage of 21x21-in, single-kernel over four-kernel hills			
1936	Ia 13	55.8	55.6	52.7	52.3	51.1
1937	Ia 13	93.6	103.3	110.1	115.8	108.3
1938	Ia 13	88.4	87.5	71.6	71.9	77.0
1939	Ia 13	79.1	89.1	84.6	90.9	79.9
Totals		316.9	335.5	319.0	330.9	316.3
4 yr ave		79.2	83.9	79.9	82.7	79.1
			4.8 bu, or 6.2 per cent yield advantage of 21x21-in, single-kernel over four-kernel hills			
1936	Ia 931	33.7	28.4	27.7	23.8	30.7
1937	Ia 931	86.1	93.6	90.7	91.7	91.3
1938	Ia 931	63.9	69.9	60.8	63.3	61.5
Totals		183.7	191.9	179.2	178.8	183.5
3 yr ave		61.2	64.0	59.7	59.6	61.2
			2.8 bu, or 4.6 per cent yield advantage of 21x21-in, single-kernel over four-kernel hills			

What Farm Electrification Needs

By B. D. Moses

FELLOW A.S.A.E.

FARM electrification must take into consideration not only the 1,786,000 farms that receive electric service, but the other 4,636,000 that do not. It must also include the manufacturers and the generating companies which sell the appliances and electrical energy. What benefits the customer must also benefit the seller. They must both make a profit on the transaction: the buyer must receive a full dollar's worth of service for every dollar he spends, and the seller must be reasonably compensated. But we are confronted with the question: How is electric service going to be extended to the other 4½ million farmers with profit to all?

Probably if each farmer could be asked whether he would like to have his farm completely electrified, he would say, "Yes, but—," the *yes* indicating his desire and maybe his prayer; the *but* including all the economic factors standing in the way. Probably, too, if each power company were asked whether it would like to serve every farm with electricity, it would also reply, "Yes, but—." It would be thinking of the high cost of serving small amounts of electricity to scattered rural customers, as contrasted with the large amounts sold to the more densely settled urban and industrial centers.

Our concern then is to see that electricity is used to such an extent and so successfully that its use spreads to each and every farm throughout our land like sunshine coming out from under a cloud. Not only should everyone receive electric service, but each user should be benefitted to the maximum possible degree.

Electric service is used for heat, light, and power. It is immediately available, clean, subject to easy or even automatic control, and if it can be made to pay its way, its use is bound to increase. Its development follows a definite sequence, greater use resulting in lower rates, and lower rates in greater use. Every time a new customer is established, every time a new use is applied, the extension reaches a little nearer the distant ranch.

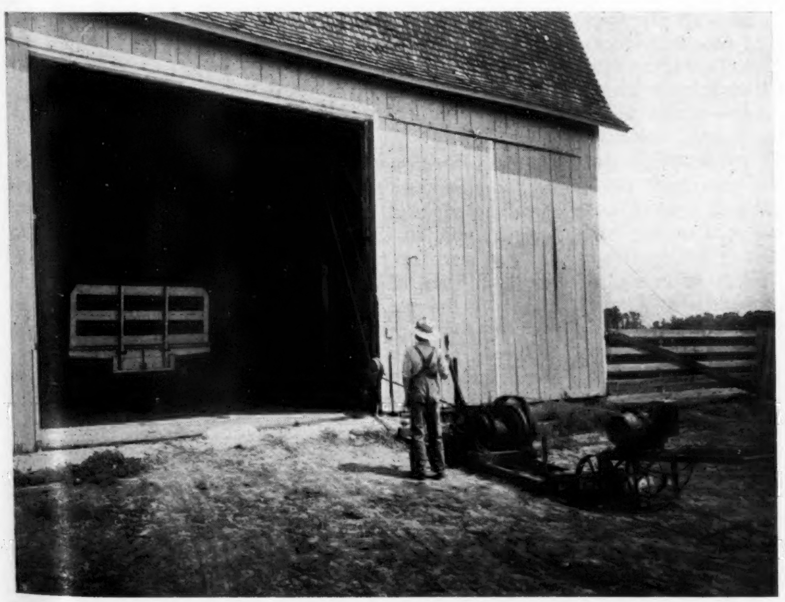
What farm electrification needs is more electric consumption per farm, lower costs, and more electrified farms. Simple, is it not?

It makes little difference how the problem is approached; it always points to the same question, "What is to be gained?" I like to think of two kinds of gain. One produces more money and may be called a profit. It comes from the application of electric power to farm operations and from the production or processing of agricultural products. The other may not produce a monetary profit, and may even increase out-of-pocket expenses. It is for the most part domestic, and results in improved living conditions and happier homes. This type of gain may be called a benefit.

Probably the greatest needs at the present time are to increase the consumption of those already having service, to increase the number of customers on existing lines, and to establish service in the marginal and remote areas.

There is no question in our minds about the practicability of such appliances as lighting in the home, washing machines, ironers, milking machines, lights in the poultry house, and irrigation, but is this knowledge general? Does everybody who uses electricity know how to use his equipment to the best advantage? For example, does every housewife know how to get the most use out of her electric range for the lowest possible electric consumption? Does the dairyman who owns a milking machine follow the best practices in order to produce high-quality milk and at the same time increase the life and usefulness of his equipment? Does every irrigator get the most out of his water, and has he the right size of pumping plant for most effective irrigation at low cost?

The preparation of the new market and the instructing of the old user involve advertising, promotion, and extension. How is the farmer going to know whether he should electrify, what kind of equipment he should get, and where he can get it? How, too, is the power man going to know whether the farmer is ready and would be benefitted? Would extension be the answer?



Our concern is to see that electricity is used to such an extent and so successfully that its use spreads to each and every farm throughout our land. Every electrical appliance should be put to as many uses as possible, thereby increasing the load factor and reducing the over-all cost

A paper presented before the Rural Electric Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 6, 1940. Abridged. Author: Associate professor of agricultural engineering and agricultural engineer in the experiment station, University of California.

Just as soon as we hear this word "extension," we are prone to dismiss it with the thought that this is the responsibility of the extension staffs of the various universities and government agencies. But this is far from the correct reaction. Every manufacturer should give serious consideration to the organization of the proper kind of educational work. His advertising should give a clear, understandable description of his motor, incubator, feed grinder, etc. There should be information of its capacity, its power requirement, cost of operation, requirements in the form of accessories; no extravagant claims, but reliable information. How often advertising material contains such propaganda as the following: "Use the superpower superior gadget; it is unexcelled by anything on the market. Reduce your costs by getting one of these tomorrow; thousands are in use. You can't go wrong. Why use old-fashioned methods when one of these wonders is right within easy reach and can be purchased on easy terms?"

There is no information about actual costs, nothing about current consumption, nothing about production in pounds per hour, nothing about the man-hours required to run the machine. In fact, there is nothing that will be of assistance toward logical selection, nor anything basic that will enable the prospective customer to make comparisons with his present methods.

Oftentimes the advertiser may give information, but it may not be correct. It may exaggerate the possibilities or capacities of the machine, or minimize its costs. However, much informative advertising has been published that is of the highest class. Some manufacturers and power companies have published leaflets, booklets, or books that have been carefully compiled and edited by authorities in agricultural fields.

What we need in advertising extension is, in my opinion, clear, concise, and accurate descriptions of equipment; more clear, understandable literature in the form of booklets or circulars by the power companies, the manufacturers, and their representatives and dealers.

TECHNIQUE IN THE OPERATION OF ELECTRIC FARM EQUIPMENT

A great deal depends upon the selection of equipment and its adjustment, and on the development of the best technique. The farmer may smile when he hears the word "technique" applied to milking a cow or brooding chicks or pigs, but the operation of appliances has much to do with their successful use. Carelessness with a milking machine may reduce milk production or result in low-quality milk; poor adjustment of the thermostat in a brooder, or faulty ventilation may result in high energy consumption per chick, high mortality, or the production of poor-grade poultry. Good judgment in the selection and proper technique in the use of electrical appliances are essential to low unit costs and best-quality produce.

We need booklets giving specific information on equipment used. We need instruction books written in simple terms. We need factual statements of what can be expected under all conditions. We need straightforward information about appliances and their use. And then we need some effective means of getting this material where it belongs. Unfortunately the man who needs these things most is always the hardest to reach. He is probably the least progressive, and may not belong to the farm organizations; takes few, if any, farm magazines, and may be readily misled by propaganda. Let us sum it up by saying that we need extension of a working knowledge about electricity to user and nonuser alike.

Much equipment, such as ensilage cutters and silo fillers, has been designed for gas engine and tractor drive, and hence is not immediately suited to electric power. Close cooperation between manufacturers of agricultural machinery and the electrical industries is needed even more than is now practiced, for the highest development of farm mechanization.

Every electrical appliance should be put to as many uses as possible, thereby increasing the load factor and reducing the over-all cost. For example, Farmer Jones has a dairy and uses an electric milking machine; he has lights in the house and all the domestic conveniences that one would reasonably expect; he cools his milk with an electric refrigerator; but he hoists his hay into the barn with a horse. He sterilizes his utensils with electrically generated steam; but has never thought of adding a hot and cold shower for his men; and a liquid manure pump has never entered his mind. One need then is greater use of what we now have.

Electric rates to the power company are all-important because its income depends upon what it charges for energy. The farmer sometimes feels the same way, and may overemphasize the price paid for electricity, because it is only a part of his total cost and may be a very small part. He does not always understand two-part rates, sliding schedules, service charges, energy charges, and off-peak rates. Such terms are confusing. Why does he pay one rate for lights, another for cooking, another for heating, and another for pumping? Simple, nondiscriminatory, and impartial rate structures are an encouragement to extension of uses.

In the development of their field men the electrical industries are aware that they are in business for a long time. These men have to return again and again to the farm, and they would rather be met with a glad hand than a square-toed boot. This is known generally by the salesmen and servicemen, but is it fully appreciated by the higher executives? Of course they are subject to the general feeling that something has to be done for the farmer, but is this one of those national problems to be left only for the Secretary of Agriculture to worry about? What farm electrification needs includes an attitude on the part of everyone in the power or electrical business, from the salesman to the president, from the bookkeeper to the board of directors, that they are out to render a service, not only talk it, but actually feel it and deliver it. Sometimes this service may be far afield from their actual duty, but it may establish confidence, and in the long run may bring in new business.

PROBLEMS OF ADAPTING ELECTRIC POWER TO FIELD WORK

Field work, such as plowing, disking, cultivating, planting, and harvesting, uses more power than all the other farming operations combined, but so far electricity has not been adapted to this work. It would not be difficult to build a machine powered by electric motors that would handle all these operations, but the first question that comes to mind is the real stickler: How are you going to get electricity to the machine? In other words, transmission is the problem. Trolleys, portable transformers, extension cables just are not satisfactory. Storage batteries are heavy, low in capacity, slow in recharging, and represent a considerable investment. What we need is a new storage battery, one that weighs one-tenth that of the present type, has ten times the capacity, can be charged in less than ten hours, is mechanically strong enough to stand the service, is nonspillable, nonfreezing, easy to keep in good condition, and can stand heavy overloads for a short time. This is a real challenge to inventors and to research departments of the electrical manufacturers. *(Continued on page 184)*

New Approaches to Farmhouse Design, Construction, and Equipment

By Joseph W. Simons
MEMBER A.S.A.E.

TO those interested in a vitalized southern agriculture comes the challenge of improving the living conditions of the southern farmer and his family. Increased interest in farmhouse design, construction, and equipment in the past few years is evidence that agricultural leaders have not overlooked this large and important humanistic problem. New, inexpensive materials, prefabrication, expanded plan services, and research activities have contributed and will continue to contribute to the development of this field.

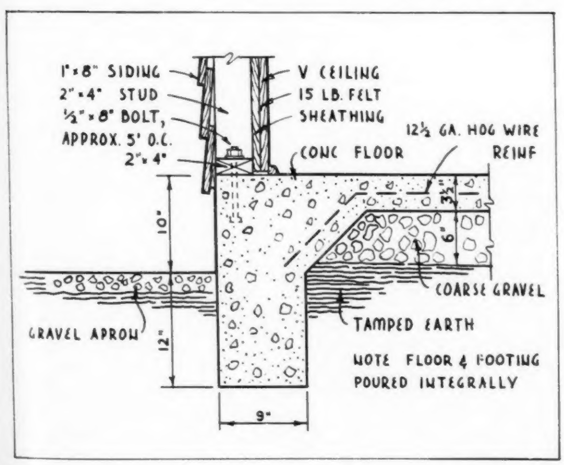
Considering the country as a whole, the trend in design of farmhouses has been toward the urban type. Undoubtedly this has been partly due to the influence of magazines in which plans for urban homes are shown, and to plans circulated by materials and equipment manufacturers designed largely for use in towns and cities. Many of these plans, while excellent for some purposes, do not provide for the activities carried on in the average farm home, which frequently differ radically from those in urban homes. Nor do they take into consideration the fact that equipment which may have influenced the design frequently is not available to farm families because of cost or lack of service facilities. Certainly we must recognize these facts in designing and building houses which will adequately serve the needs of farm families.

Changes in construction and in the use of materials in farmhouses have been influenced far more by urban developments than by any local or general movements to utilize native materials. Those most interested in a widespread program of farm building repair and construction now recognize what one solution of the problem of low-cost buildings is the use of materials which can be obtained from the farm or locally, and the contribution by the owner and his farm hands of a large share of the labor required. In such a program not only must new methods be introduced, but also the use of old proven methods should be recommended and urged upon the farmer. Efforts along this line are being undertaken by the Bureau of Agricultural Chemistry and Engineering in cooperation with the University of Georgia and the University of Wisconsin; and by other institutions such as the University of Arkansas and Tuskegee Institute.

For the past four years at Athens, Georgia, our project has placed particular emphasis on the matter of comfort, although we have considered such factors as first cost, maintenance, appearance, ease of fabrication, and fire safety.

To be of practical value the results of farm structures research must be applied to the building and remodeling of actual farmhouses. In the vicinity of Athens we are now doing that by assisting farmers with their house building problems. We furnish the cooperator with plans and specifications, suggest the materials he might use, and give limited supervision to the construction of the house. In return, the owner provides us with labor and material records. He also permits those engaged in the research project to make temperature studies and to use his house for a limited time as a demonstration to interested parties. Only

A paper presented before a meeting of the Southern Section of the American Society of Agricultural Engineers at Atlanta, Ga., February 6, 1941. Author: Assistant agricultural engineer, farm structures research division, Bureau of Agricultural Chemistry and Engineering,



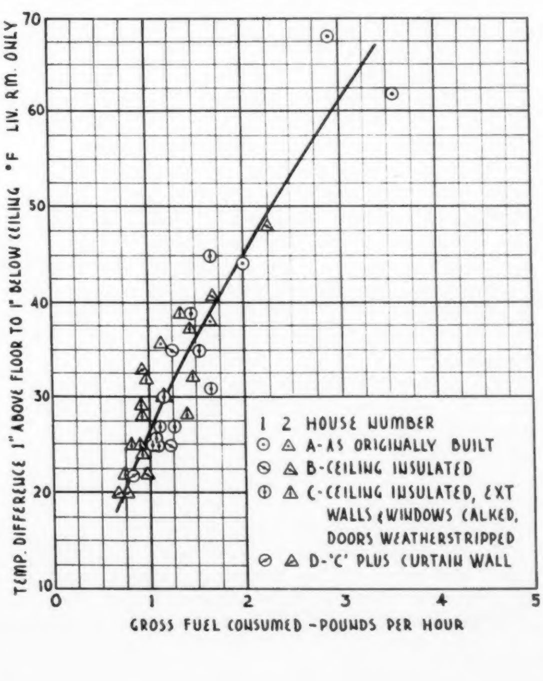


Fig. 1 (Above) Detail of concrete slab floor construction. Fig. 2 (Right) Relation of fuel consumption to air temperature difference from floor to ceiling in winter tests of three-room houses

a very limited number of farmhouses can be improved by our project and other similar projects through direct cooperation with owners. However, such projects not only provide needed technical information, but also serve as proving grounds for developing methods of approaching the general farm building problem on a broad scale.

The most common floor construction in the South is a wood floor and joist system supported by piers. In winter, cold winds blowing under the house result in cold floors and tend to increase fuel consumption. Our studies in the test houses have shown that installing curtain walls between piers resulted in reducing the fuel consumption on an average of from 12 to 19 per cent, depending upon the construction of the balance of the house and the wind velocity. The studies were made with wind velocities ranging from 3 to 9 mph. Curtain walls would increase the cost of a house relatively little and would seem to be a worthwhile expenditure; they would also enhance the appearance of the structure.

FLOOR INFLUENCES ON COMFORT

Studies of concrete slab floors laid on gravel fills on the ground showed that much more uniform temperatures are maintained than in the case of wood floors supported by piers, and that the heat loss in winter is much less. However, in summer, the cooling process during the night is slower for the concrete floors. It is, therefore, highly desirable to prevent the sun's rays from striking the concrete floor because of its high heat capacity.

Of course there are advantages and disadvantages for both types of floors. Wood floors are easy to build and lumber is readily available at a reasonable cost in most sections. However, they are difficult to finish so as to be easily maintained under farm conditions and are not proof against fire, termites, or vermin. As ordinarily built, the pier construction used with wood floors has little resistance to damage by high winds. It is generally agreed, however, that the resilience of a wood floor and its relatively low heat conductivity tend to promote the comfort of persons standing or working on such a floor.

The concrete floor has the advantage of being fire, wind, termite, and vermin resistant, and is sanitary. The surface may be colored with mineral pigment incorporated with the cement mix, or covered with asphalt tile or wood, thus giving a variety of finishes. In very low-cost construction the floor may be left bare and smoothed to a nonslipping surface, although a covering or finish is highly desirable. Often there is objection to a bare concrete floor.

There are several problems in connection with the use of concrete slab floors in low-cost farmhouses about which various authorities do not agree. It would seem that this one subject should provide an excellent opportunity for some intensive research. The question of economical moisture-proofing is one deserving much consideration. Another question is that of the minimum thickness for a floor slab, with the proper amount of reinforcing, which will be economical to use.

Fig. 1 shows a type of floor which we believe to be fairly economical on level sites. This was laid recently in a house in Jackson County. A one-course, 3½-in slab, reinforced with No. 12½ gage woven wire was placed over a 6-in gravel fill. The site is well drained, and, therefore, there should be little difficulty due to moisture. This particular floor will be covered with asphalt tile.

In our initial studies in occupied farm dwellings we found that those houses having the loosest construction were the most comfortable in summer, but of course they were the most uncomfortable in winter. Also, those houses with the least massive construction had the advantage in summer of more rapid cooling at night. These results were borne out by the studies in the test houses. Particularly striking were the results obtained under winter conditions. In these tests one type of construction used was typical of the average farmhouse; lapped weatherboarding on the exterior, studs and V-ceiling on the interior. It was found that with this wall construction the fuel consumption increased about 56 per cent when the wind velocity increased from 3 to 9.7 mph. It was also noted that the two three-room experimental houses, although built on the same plan and of similar materials with a difference in age of less than 2 years, did not require the same amount of fuel. Fuel consumption in the older house was approximately one-third more, with equal temperatures being maintained in both houses.

In another series of tests all exterior joints in the siding and the cracks around the windows were caulked, and doors were weatherstripped to provide tight construction without changing the heat transmission characteristics of the structure. This procedure reduced infiltration of air through the walls, windows, and doors, and resulted in an average reduction in fuel consumption of from 23 to 39 per cent with the wind velocity ranging from 3.0 to 9.0 mph. The percentage reduction would also be influenced by the amount of heat lost through the floor and ceiling.

WALL CONSTRUCTION IN RELATION TO CLIMATIC CONDITIONS

In sections of the country farther north, where winter cold is the main problem, the obvious thing to do is to seal the outside wall as tightly as possible in order to take advantage of the air space within the wall. In areas farther south, where summer heat presents the main problem, the walls should be constructed somewhat loosely. However, in this particular section where both summer and winter extremes of temperature are encountered, a type of construction is needed which will be effective in both cold and hot weather and provide a reasonable degree of comfort throughout the year.

Such a type of construction might employ a relatively loose exterior wall covering such as lapped weatherboarding or vertical boards and battens. The sheathing would be placed on the interior, and be covered with building paper and V-ceiling or other interior wall finish. This construction would allow some air movement within the wall and provide some means of escape for absorbed heat in summer. In winter, infiltration of air through the wall into the house would be kept at a minimum, and the 1½-inch thickness of wood or equivalent material would provide a fair degree of heat insulation.

There are other aspects of design and construction which have particular reference to summer conditions. For example, we have found that anything which we do in attempting to promote comfort in low-cost housing has little effect so long as solar radiation is permitted to enter the house through windows and doors. In our studies ordinary roller window shades reduced the daytime average of air temperature from 3 to 4 F (degrees Fahrenheit) and the average temperature of the wall, ceiling, and floor surfaces about one degree. However, for some people, the reduction in air movement tends to offset the reduction in temperature. Although an analysis has not been completed, a preliminary inspection of the data and observations of the investigators indicate that the use of slatted blinds on the outside of windows and doors is much more effective and has the added advantage of permitting the entrance of air. The disadvantage in the use of exterior blinds is the incon-

venience of operating them, especially when full length screens are used. The effectiveness of various types of window shading has also been studied by other investigators[1].

The use of high ceilings has been quite customary in the past in the southern states, although the present tendency, particularly in low-cost houses, is to reduce ceiling heights. In the experimental houses, all of which are of one-story construction, we found that there was no appreciable difference in air or surface temperature when comparing ceiling heights of 8 and 10 ft. It is obvious that houses with the lower ceiling heights would be cheaper to build and easier to heat in winter.

Attic ventilation by natural means is a subject of some discussion. Our studies have shown that gable louvers of the size ordinarily used are of little benefit in producing greater comfort in the rooms below. The use of such louvers, together with an opening 2 in wide running the full length of the cornice, resulted in some reduction in ceiling surface temperature. It is felt that the entire area of the gables should be louvered to be really effective; however, we have conducted no tests to substantiate this belief.

KITCHEN COMFORT PROBLEMS

The kitchen is probably the most uncomfortable room in farm homes in the South, where wood-burning ranges are used for cooking. We have had fairly good results in one-story houses with the use of a large grille, which can be closed in the winter, installed in the ceiling directly over the stove. With such an installation, sufficient exhaust area must be provided in the attic. Since cross ventilation is also an aid in solving the problem of hot kitchens, more thought should be given to this factor in designing farmhouses. In one occupied house the range was located in one end of a combination kitchen-dining room. There was no cross ventilation in this portion of the room so that extremely high temperatures were experienced, particularly during periods of meal preparation. It was decided that the best remedy for the situation was to cut a door, with transom above, through the partition into an adjacent bedroom. Although analysis of data has not been completed, both the investigators and occupants of the house agreed that the installation produced desirable results and was more than worth the cost. While it is not considered good practice to connect a bedroom with the kitchen in this manner, something must be sacrificed occasionally in order to produce greater comfort.

Other phases of our research have particular reference to winter conditions. The problem of reducing stratisfication or air temperature variation from floor to ceiling has been a matter of some concern to many engineers. The use of various types of heating units and forced air circulation have been studied. Some of the heating installations, especially those utilizing forced air, undoubtedly have some influence on stratification. However, we believe that in most of these studies little thought has been given to the heat transmission and infiltration characteristics of the construction. The customary practice is to assume approximately a 2 per cent change in temperature from that at the 5-ft level for each foot above or below this level. In a house having a ceiling height of 8 ft with a temperature of 72 F at the 5-ft level, the temperature variation from floor to ceiling, using the allowance mentioned would be 11½ F. In our studies in the test houses temperature differences between floor and ceiling as great as 65 F were measured with most of the differences falling between 20 and 40 F. Fig. 2 is a curve showing stratification or air temperature difference from floor to ceiling plotted against fuel consumption rates illustrating the relation which we found between these two factors. It will be noted that the higher the fuel rate, the greater was the stratification. In terms of a fixed temperature at the breathing level this means that the greater the heat loss, the greater is the amount of fuel that will be required; in turn, greater fuel consumption produces more pronounced stratification. One effective method of reducing stratification, therefore, is to reduce the heat loss from the house by various means.

The use of cottonseed hulls for insulation has been one of the phases of our project in which many people have expressed a great interest. In our winter tests we found that a 3⅝-in thickness of hulls on the ceiling of the three-room test houses produced an average reduction in fuel consumption of from 16 to 25 per cent, depending upon the amount of infiltration through the walls and the heat loss through the floor. In the one-room houses having high heat transmission characteristics, the highest reduction was about 37 per cent.

Our studies revealed that in summer insulation had little effect on air temperatures within the house under normal living conditions. However, the ceiling surface temperatures were reduced noticeably during the day. Although no method has been devised for determining the exact effect upon the human body of lowering temperatures of surrounding surfaces, it is known that cooler surfaces result in increased bodily comfort.

Resistance to fire is an important quality in an insulating material. For this reason we are now recommending treatment with an ammonium sulphate solution which renders the hulls reasonably fire-resistant. Further study of various treatments is being made in an effort to improve the effectiveness and to determine the permanency of the treatment.

In normal seasons the cost of cottonseed hulls is around $10 per ton. With a density of 10 or 11 lb per cu ft and a layer thickness of 3⅝ in, the cost per square foot of ceiling area would be about 1¾ cents. Ammonium sulphate required for the treatment costs less than one cent per square foot, making the total cost of materials slightly less than 2¾ cents per square foot.

HEATING EQUIPMENT TO MEET COST AND FARM FUEL REQUIREMENTS

In touching on the subject of heating equipment, it might be well to emphasize the fact that little attention has been given to the development of low-cost heating equipment which will provide satisfactory heat when using fuel obtained from the farm. This is indeed a problem warranting serious consideration. The elimination of the inefficient fireplaces and much of the heavy masonry required would be a big step forward as affecting house design, cost, and comfort.

There is the question of how much one can afford to spend for heating equipment. The average five-room house being built by the FSA costs around $1400 to $1500, a figure which is near the limit the farmer can pay. Of this amount, $50 to $70 is spent in constructing the fireplace and chimney which in most cases comprises the heating system for the house. These houses might be considered as near the minimum standard for construction, finish, and equipment; therefore it would seem impossible, and certainly undesirable to spend less on the house in order to provide better heating equipment. Yet there is no question but that the farmer and his family should have better heating facilities than they now have.

Until we do have better heating systems the only thing we can do is to utilize some improvements on existing ones.

[1]Houghten, F. C. et al. Studies of solar radiation through bare and shaded windows. Jour. A.S.H.V.E. Vol. 40:101-108.

In our studies in the experimental houses we have found that where an air-circulating heater is employed, registers in the partitions near the floor and near the ceiling provide much more uniform heating if the interior doors are open; however, they are fairly satisfactory with interior doors closed. Registers near the ceiling in conjunction with a cold-air return under the floor were tried, but this arrangement in addition to being more expensive, was not as satisfactory as the registers alone. Another arrangement which might be even cheaper would be to provide only the registers near the ceiling or transoms above the doors and allow the colder air to return through open doors. While our tests have not included cheaper types of heaters, some decrease in stratification would no doubt be obtained with wall registers when common stoves are used.

Although our studies at Athens have revealed much information which I have not been able to give in this paper, I have tried to present to you in general terms those results which have the greatest practical application at this time. As stated before, there are many problems yet to be solved, and we must intensify our efforts in order that some of these questions will be answered before a huge program of farm housing has to be undertaken. Certainly that day cannot be far off, for needed improvements in farm buildings have been postponed again and again. When the defense industries slacken production, the field of farm housing will provide opportunity for productive employment of men and utilization of potential natural and industrial resources, while making the difficult transition from emergency to normal conditions.

What Farm Electrification Needs

(Continued from page 180)

There is a great deal of research work being done by universities, power companies, manufacturers, and others, with some lost motion and occasional duplication. Indices, bibliographies, and abstracts are available, but there seems to be a need for some centralized bureau where these could be filed and master indices made available to investigators.

There are several fields that seem fantastic and full of impossibilities. They need exploration and study, but they could be classified and analyzed, and worthy projects studied. I feel that the following list needs consideration:

1 Electromagnetic fields and plant growth.

2 Continued investigation of the biological effects of various wave lengths of radiant energy on plants and animals, insects, bacteria, and molds.

3 The further application of the X-ray to the inspection of various fruits, nuts, and seeds.

4 Electropasteurizing and processing of various fruit juices and other agricultural products.

5 Electric pretreatment of seed.

6 Heating and drying by the use of radiant energy.

7 Heating by means of electromagnetic induction and electrical conduction.

8 Panel heating and panel cooling in farm homes as well as in some of the animal shelters.

9 The application of electromagnetic induction for certain shaking operations such as screens in seed-cleaning machinery.

10 The development of a storage battery or accumulator involving entirely new principles.

11 The development of low-cost dependable line construction.

12 Further simplification of wiring devices for ease and safety in operation.

There should be harmonious cooperation between all the different generating and distributing agencies, publicly owned, privately owned, or cooperatives, large or small. During the last twenty years lines have spread from widely separated communities to large areas covering several states. Small steam plants and still smaller hydroelectric plants have been supplanted with large central generating plants that are interconnected. But still further interconnection and standardization are needed to protect farmers against serious outages. Uniform policies and probably standardized practices are needed in order to extend the lines into sparsely settled or remote areas and distribute the burden of expensive overhead fairly over the territories served.

Educationally, we need well-planned elementary courses that deal with the fundamentals of electricity and its applications. We need college courses that go into the theory underlying the functioning of various processes. We need graduate students for training along the lines of basic research. We need well-organized technical literature, handbooks, and ready references suitable to high schools, vocational schools, and colleges, of such a character as to serve not only the student but also the engineer, farmer, manufacturer, and power company.

When we recall that forty years ago the farm electric load was practically zero, that twenty years ago when C.R.E.A. came into being it was considered visionary, and that last year there were 3,320,000 kw-hr sold to farmers for $94,000,000, we should feel definitely encouraged. It is my hope that nothing in this discussion will be taken as faultfinding, and that all suggestions will be accepted as constructive criticism.

There is need for dreaming and planning; for research along sensible but revolutionary lines. We need inspiration, new ideas, and new methods of attack. We need dynamic dreamers who can inspire the more practical workers to produce results from existing and potential projects.

Electricity Is Lowest Farm Expense

THE cost of electricity is usually the smallest expense item in producing any commodity on a well-managed farm, according to John C. Scott in a paper prepared for the rural sales section, annual sales conference, Edison Electric Institute, held recently in Chicago.

Industries use electricity to reduce their cost of production and at the same time assist in producing better quality commodities, and the farmer can use more of it to his economic advantage.

An example cited by Mr. Scott is that of the Dodds Brothers, Marymoor Farm, western Washington, who receive a premium of 5 to 10 cents a quart on all the milk they produce. Other dairymen have been puzzled as to how the Dodds Brothers can produce milk of such quality that buyers will pay 5 or 10 cents a quart more. Mr. Scott quoted Ralph Dodds as saying "The real secret in producing high quality milk is the proper cleaning and sterilization of the milk utensils. Our utensils are thoroughly washed with plenty of hot water from electric dairy water heaters, and then put into an electrically heated sterilizer. When it comes to producing a better quality of milk, man power or other types of apparatus could not be compared with electric service and proper electric equipment."

Hens, said Mr. Scott, lay from 10 to 20 eggs less each annually when compelled to drink water colder than 50 F. The average poultryman with 1,000 laying hens can get each hen to lay 12 more eggs per season by providing an electric water warmer. The 1,200 dozen eggs more will mean from $250 to $300 additional income for the farmer, against the water warmer equipment and wiring cost of from $20 to $35, and current consumption costing from $10 to $25.

Storage of Grain Sorghums

By F. C. Fenton
FELLOW A.S.A.E.

GRAIN sorghums give trouble in storage for two primary reasons: (1) they contain too much moisture when threshed in the fall to keep safely in storage, and (2) they are commonly stored in unventilated bins which do not permit them to dry out.

There is nothing in the nature of grain sorghum nor in its behavior under storage which is fundamentally different than other grains. All grains heat and mold when stored in bulk with an excess moisture content, in a manner similar to sorghums.

The nature of the sorghum crop and the conditions of harvest make it quite probable that the grain itself will contain a high moisture content when threshed in the fall. The grain sorghum plant stays green and continues to grow if moisture is present, until killed by frost. Although the grain may be well matured in certain years, the green plant and juicy stalk feed moisture up to the grain, preventing it from drying out until frost stops plant growth. Many seasons the crop is not well matured when growth is stopped by freezing, in which case immature kernels contain a high moisture content.

It is not usually practicable in all seasons to delay the harvesting of grain sorghums until they are dry enough to keep in storage. The tendency to lodge in the high winds common on the western plains makes it desirable to get the harvesting done promptly. The new dwarf varieties, bred for the combine, have short, stiffer stalks, and on the whole do not lodge badly. During some fall seasons, weather conditions are not good for drying grain sorghums. When frosts come early and cold weather moves in, there is likely to be little chance for drying.

Sorghum is like the corn crop, in that it matures late in the fall and is commonly harvested with a high moisture content. Corn is stored in ventilated cribs in the ear to permit drying during the winter and spring months. Recent research in corn storage has shown that most of the drying in corn is accomplished after warm spring weather arrives, and that little drying occurs during cold winter weather.

The grower of grain sorghums should realize that the grain is likely to contain more moisture than is safe for storage in unventilated bins, and it is more difficult to judge the moisture content by the feel of the grain in the hand than in the case of wheat. Sorghums containing more than 14 per cent moisture are likely to heat in storage, but grain with 16 or even 17 per cent moisture feels hard and dry to the touch, especially when cold.

Seasons vary widely in the southwest where sorghums are raised. In certain seasons it will be impossible to harvest and thresh grain with moisture content low enough for safe storage. In other years, most of the grain should be dry and little trouble encountered.

The fall of 1939 was the driest in Kansas history. All sorghum which was bound and shocked or headed before threshing was dry, some samples containing even less than 10 per cent moisture. And yet a considerable amount of damp grain was harvested during that fall.

At the other extreme was the fall of 1929, when the fields of the Fort Hays Experiment Station were so wet that combines could not be operated until the ground was frozen on December 23 and 24. Eighteen 10-acre plots of different varieties of grain sorghums were harvested with the combine. The moisture content ranged from 15.2 to 21.6 per cent, with most varieties containing 17 to 18 per cent.

During the past eight years, when studies were made on the moisture content of newly harvested sorghums, on only two years was the moisture content low enough for safe storage.

Equilibrium Moisture Content. Grain sorghums, like other grains, are hygroscopic in nature; that is, they gain or lose moisture when the vapor pressure in space surrounding the grain is greater or less than the vapor pressure exerted by the moisture within the grain. Grains tend to reach and maintain an equilibrium moisture content with the surrounding air. This equilibrium moisture content has been determined by exposing samples of the grain to a constant temperature and relative humidity maintained by sulphuric acid-water solutions.

Equilibrium curves for Blackhull kafir, shown in Fig. 1, disclose an interesting and important relationship. The equilibrium moisture content of this grain is higher at lower temperatures. Stating it another way, as the temperature of the grain rises, moisture tends to leave the grain if outside vapor pressure conditions remain the same. This moisture which must leave the grain with a rise in tem-

A paper presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 4, 1940. (Contribution No. 103 of the agricultural engineering department, Kansas State College.) A paper, entitled "Harvesting of Grain Sorghums," by the same author, appeared in AGRICULTURAL ENGINEERING for April 1941. Author: Professor and head of the agricultural engineering department, Kansas State College.

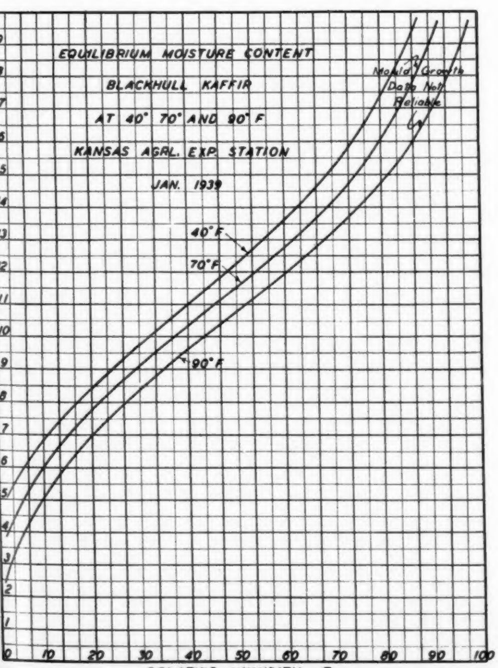


Fig. 1 Equilibrium moisture content of Blackhull kafir

perature, may account for a part of the sweating of grain in storage which has so often been observed by men in the handling of grain. When grain at the equilibrium moisture content rises in temperature, it gives off moisture. If the grain is stored in a large bulk, with no chance for the moisture to escape into the atmosphere, the moisture remains between the kernels in the form of free water. When the amount of free water driven out of the kernels by the rise in temperature is sufficient to be noticed, the grain is said to be sweating. Sweating has been observed by almost everyone who has handled grain. It is an accepted phenomenon believed by many to be necessary before grain will keep in storage. Based upon close observation of experimental wheat and sorghum in storage during the last ten years, it is my opinion that sweating of grain in storage is both unnecessary and undesirable. It is a phenomenon of warm grain which already holds its full quota or perhaps an excess of moisture, stored in unventilated bins. Many examples have been observed of grain which was dry when it entered the bins, and which continued to cool down without any evidence of sweating. Sweating in unventilated bins or large bulk storage promotes mold growth and causes musty grain.

The problem of safe storage of grain sorghum is primarily that of removing the excess moisture before heating occurs. If the weather is cold and the grain is cool when placed in the bin, there is usually no storage trouble until warm spring weather comes on. Sometimes late fall warm spells may start heating in newly threshed sorghums, but usually the spring is the first danger period.

Our problem is to utilize drying conditions which prevail in the sorghum-producing areas during the fall, winter, and spring months to dry the grain down to a safe moisture content.

Theory of Drying Grain. As pointed out by Barre[1], many of the problems connected with the drying and storage of grain become clearer when approached from the standpoint of vapor pressures. Vapor pressures of Blackhull kafir and Wheatland milo have been determined and plotted in the curves shown in Fig. 2. These curves show that the temperature of the grain is of greatest importance in affecting vapor pressure. As the temperature of the grain rises, the vapor pressure of the moisture held within the grain increases rapidly. The temperature of the grain is the greatest single factor in grain drying. The moisture content of the sorghum is also a factor in affecting vapor pressure, but is of much less importance than temperature. As the moisture content increases up to 20 per cent, as shown in the curves, the vapor pressure of the grain approaches that of saturated water vapor at that temperature. Further increases in the moisture content of grain beyond 20 per cent have relatively little effect on the vapor pressure.

Two principles of grain drying may be stated as follows:

1 Grain gains or loses moisture because of the vapor pressure difference between the grain itself and the surrounding air. If the vapor pressure of the grain is higher than the pressure in the space surrounding the grain, moisture will flow out of the grain. If the reverse is true, moisture will flow into the grain and there will be a gain in moisture content.

2 The rate at which a grain gains or loses moisture is roughly proportional to the magnitude of the vapor pressure difference which prevails between the grain and the surrounding space. This rate is affected by the resistance to the movement of moisture vapor set up by the surface

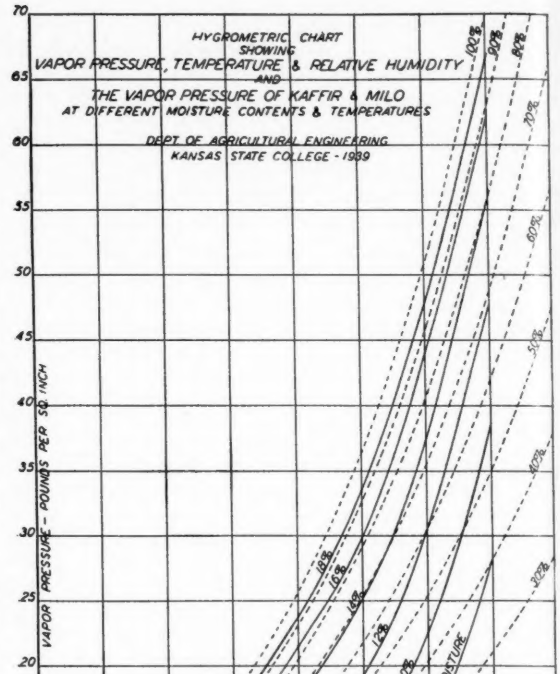


Fig. 2 Vapor pressures of grain sorghum at different temperatures and moisture contents, plotted on standard hygrometric chart showing temperature and relative humidity

layers of the grain. Sorghums resist the movement of water vapor more than wheat and will dry less rapidly under similar conditions.

The curves in Fig. 2 may be used as a guide in the ventilation and drying of grain sorghums. Vapor pressure of the sorghum can be determined from its temperature and moisture content. Vapor pressure in the atmosphere is determined from the temperature and relative humidity, which are easily measured and which are reported daily by the weather bureau stations. A vapor pressure difference of 0.05 to 0.10 psi (pounds per square inch) is sufficient for effective drying.

In order to dry grain sorghums effectively by ventilation in storage, two conditions must be provided, as follows:

1 The vapor pressure of the air which is made to flow through the grain must be lower than the vapor pressure of the moisture within the kernels of the grain itself.

2 The movement of air through the grain must be rapid enough to maintain some vapor pressure difference until the air leaves the grain.

Condition No. 1 is easily satisfied by the dry air (low humidity air) which usually prevails during the fall and winter months in regions which produce grain sorghums.

[1]Barre, H. J. Vapor pressures in studying moisture transfer problems. Agr. Engr. 19(6) (June 1938).

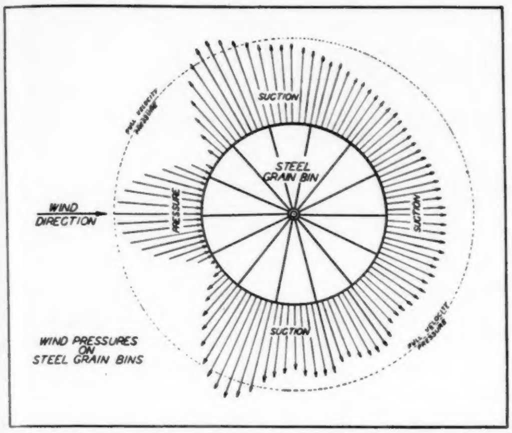


Fig. 3 Approximate distribution of wind pressures on the outside surface of a circular steel grain bin

As the winter comes on and the mean air temperatures drop, the vapor pressures drop regardless of the relative humidity. Cold winter air has a low vapor pressure. The grain also has a low vapor pressure, but the lag in cooling of the grain in the bin is advantageous for the drying process. Warm grain and cold air create a large vapor pressure difference. The damper the grain, of course, the higher the vapor pressure set up within the kernels. However, temperature of the grain and air is of greater importance than either moisture content of grain or relative humidity. Hot grain, either due to natural heating or artificial heating, has a high vapor pressure and is in ideal condition for drying.

The movement of air through the grain is a matter of mechanics. Resistance to air movement is not large, because 38 to 40 per cent of sorghums is air space. Just how rapidly the air must flow for most effective drying is difficult to determine. Small laboratory tests indicate that rate of loss of moisture continues to increase with air movements up to 1200 air changes per hour, or 20 air changes per minute. At this rate of air change the loss of moisture was 0.33 per cent per hour with a vapor pressure difference of 0.10 psi.

Methods of Ventilation of Sorghums in Storage. In order to be effective, ventilation must provide for a definite air movement through the air spaces in the grain. An opening in the walls of a bin may be said to provide ventilation, but unless there is some force to make the air flow through the grain, the ventilation will not be effective in drying. Forces which can be used to create ventilation in grain bins are (1) force of the wind, (2) difference in temperature, and (3) mechanical ventilation with power-driven fans.

There are several ways by which wind pressure can create effective ventilation. Wind blowing upon a cylindrically shaped bin creates an increased pressure on part of the windward side and a suction on the remainder (Fig. 3). These two forces act together to cause air movement through perforated side walls and thus through the grain. The perforated side wall, when combined with a large central chamber so that the air need not pass through too much grain, will give effective ventilation. Another method of utilizing wind is by use of cowls or cupolas which have been designed to draw air out (suction cupolas) or to force air into a given space (pressure cowls). Suction cupolas draw air out of the space to which they are connected. This principle has been incorporated into a commercial bin as illustrated in Fig. 4. This bin combines wind pressure on the windward side and suction on the leeward, with suction through the central flue created by the revolving cupola. When used in the 500-bu size, this bin has been effective in storing grain sorghums on the Fort Hays Station.

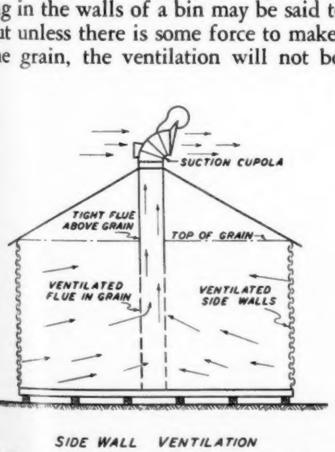
The most effective wind ventilation has been provided by a pressure cowl. The pressure cowl is held by a vane so that the wind blows directly into the mouth of the opening and the full pressure of the wind is available to create air movement through grain. The magnitude of these pressures due to the wind is rather small (Fig. 5 and Table 1).

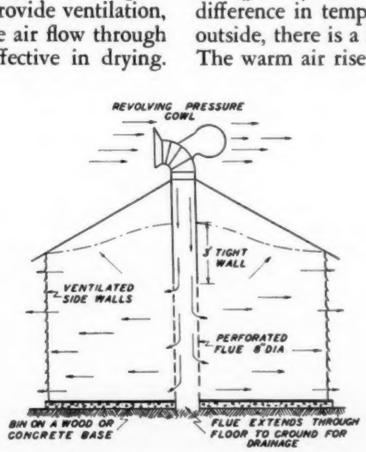
TABLE 1. VELOCITY PRESSURES CREATED BY WINDS OF MODERATE VELOCITY

True wind speed	Pressure
10 miles per hour	0.048 inches of water
15 " " "	0.11 " " "
20 " " "	0.196 " " "
25 " " "	0.306 " " "
30 " " "	0.44 " " "
35 " " "	0.62 " " "
40 " " "	0.78 " " "

The air movement through sorghum caused by wind is rather small, and this air movement cannot be expected to dry excessively damp grain, particularly during warm weather, when molding may occur in a few days. But during the fall, winter, and spring months, sorghums need not be dried rapidly, and the natural ventilation which can be secured by wind may suffice.

Effect of Heat in Ventilation. Whenever there exists a difference in temperature between stored grain and the air outside, there is a tendency for convection currents to form. The warm air rises and is displaced by cooler air. This air





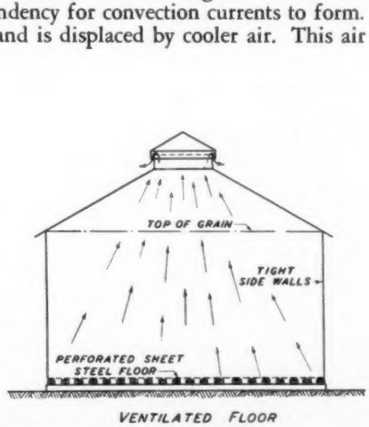


Fig. 4 (Left) Ventilation by wind pressure and suction. Fig. 5 (Center) Ventilation by the wind-pressure cowl, the most effective type of ventilation by wind. Fig. 6 (Right) Ventilation by means of a perforated or screen floor. This method has given good results

movement goes on with changes in temperature, and even in bins where no provision for ventilation is made, some movement of air takes place and this is probably the cause of the slow natural drying in common bins. In order to facilitate the movement of air due to temperature differences, the bin with a floor made of screen, or what is commonly called bottom ventilation, was devised. A bin constructed as shown in Fig. 5 with a screen floor and cupola in the roof permits free movement of air upward or downward through the grain. Any difference in temperature between air and grain will create an air movement through the grain. Although the forces which cause air movement are very small, the resistance to air flow are also small. Differences in temperature occur almost continuously due to the normal changes in day and night temperature. This type of ventilated bin has given good service in the practical storage of grain sorghums on the Fort Hays Station. No bin of this type has been manufactured and sold by bin manufacturers, but a number have indicated that they would be willing to make such a bin if there is a demand for it. The conventional bin of wooden construction can be constructed with a perforated sheet steel floor and would then have effective ventilation.

These methods of natural ventilation could not be expected to dry out sorghums of extremely high moisture content, but should take care of grain having 15 to 16 per cent placed in storage during the cool weather of the late fall.

Natural ventilation systems work continuously in poor drying weather as well as good. During some seasons conditions for drying may be poor and little drying can be expected. The fall and winter of 1940-41 was cold and damp. Much of the grain in the field and shock was too wet to thresh and store safely, and certainly if grain will not dry in the open air, it will not dry in a bin, even with the best ventilation system.

Mechanical Ventilation. Mechanical ventilation can be made much more effective in drying grain sorghums than natural ventilation because the movement through the grain is more rapid.

There are many periods during the fall, winter, and spring when effective drying of sorghums can be accomplished by forced air ventilation. Any time the grain is heating would be the ideal time because rapid drying would result and the heating would be stopped. Any time in the fall when a sharp drop in temperature brings the air temperature below that of the grain would be a good time to blow air through the grain. If drying to a safe moisture content has not been accomplished during the fall and winter months, additional drying may be accomplished effectively during the spring after the grain has been warmed up by the warm weather. The best time for spring ventilation would be during a late spring freeze when low vapor pressures are certain. The vapor pressure curves in Fig. 2 may be used as a guide to show when effective drying can be accomplished by mechanical ventilation.

It is important to have an even distribution of air throughout the entire mass of grain. This can be done by having equal distances for the air to travel through the grain. Three practical methods of doing this are indicated by the drawings in Fig. 7. The method indicated by No. 1 is applicable to bins of all kinds where a false floor covered with perforated sheet steel can be installed and the air blown into the space beneath the floor. Method No. 2 can be used in any type of bin. The perforated chamber is set upon the floor in the center of the bin and connected by a pipe to the blower outside of the bin. Method No. 3 is suitable only for the steel bins of circular construction which have perforated side walls and a central flue extending vertically through the grain. In the case of the commercial bin shown in Fig. 5, an emergency ventilation system can be provided by carrying the pipe from the blower to the revolving cupola and stopping up the space around the pipe. Air is then blown downward through the central flue and outward from the flue through the grain.

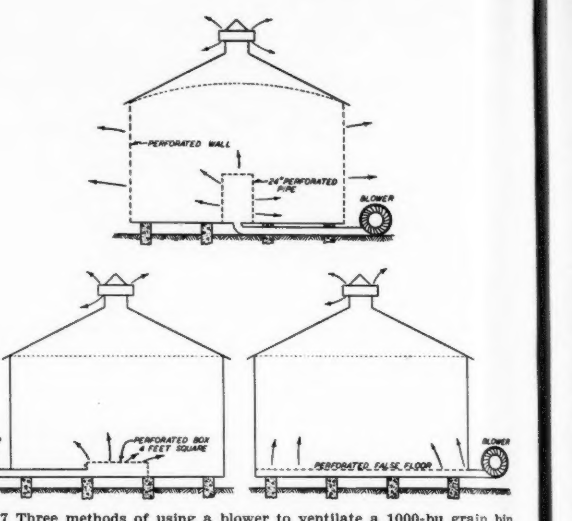


Fig. 7 Three methods of using a blower to ventilate a 1000-bu grain bin

The distance through grain which air must travel is a factor of some importance. Greater depths of grain require higher air pressures to maintain the desired air movements. Greater depth of grain would mean that the fan would need to be operated at a higher speed to secure the desired air flow. Greater depth of grain means that the volume of moisture to be removed is large. To remove 3 per cent of moisture from 1000 bu of grain sorghums means taking out about 1600 lb, or 200 gal of water.

Customer Surveys Build Business

THE problem of developing the rural load has become much more difficult and makes it necessary to study more carefully some plan of reaching these customers with a sales program at a reasonable cost, according to E. C. Easter, at the rural sales section, annual sales conference, Edison Electric Institute, held recently at Chicago.

The experience of the Alabama Power Company, Mr. Easter said, has been that, while the company's merchandise salesmen and the appliance dealers are interested in the rural market, their sales efforts can be made much more effective and economical by a prospect list furnished by someone in position to be more familiar with the customers.

The company's agricultural engineers, who work with farmers in their problems pertaining to the use of electricity, representatives of the rural and towns division, and the local or district managers began systematic surveys of all the rural lines of the company in June, 1940. Prospective customers all along the lines were listed, with customers who were considered to be equipment prospects, from the knowledge of the three men and the meter book containing each customer's account.

Copies of the lists were furnished to company salesmen, wiring contractors, and appliance dealers. Cost of the surveys was about 63 cents per mile of line surveyed.

Mr. Easter estimates that the increased sales to new customers by use of the additional equipment will amount to 1,500,000 kwh, and about $57,000 in annual revenue. The equipment sales amount to about $200,000.

An Agricultural Engineer Looks at Farm Chemurgy

By Leonard J. Fletcher

FELLOW A.S.A.E.

EACH person who has become interested in the farm chemurgic movement has, in general, established in his mind certain opinions and conclusions. Some see in the movement great promise for increased utilization of farm products. Others see many new industries developing in various parts of the country. Others see an improvement in our standard of living by making available more useful things, while still others see from chemurgy little substantial improvement or gain in any phase of our national life.

In the program of farm chemurgy, there is included the production of new kinds of crops and new utilization for crops or portions of crops now produced, both of which call for modified or new farm equipment for use in production and harvesting, and, likely, new equipment for special processing or packaging on the farm or at collecting stations. In general, the mechanization of any process must follow and not precede certain other prerequisite activities.

Many promises have been made in the name of farm chemurgy. In some cases those doing the promising have not been hampered by facts. There are some who have painted the picture of nonfood utilization of farm surpluses as holding forth great possibilities of quickly removing the surplus problem from our economic picture. Others describe the great field of industrial utilization of farm residues.

RELATIVE RAW MATERIAL REQUIREMENTS FOR DURABLE GOODS AND DAILY SUPPLIES

Let us do a little comparing. In 1937 we produced four million automobiles. People have become most enthused over the possibility of using certain materials produced from farm crops in the manufacturing of parts of these automobiles. This is a most desirable development which should result in better cars, but just let us see how much of those things which the farmer produces might be thus employed. If every part of every automobile made in 1937 were made from corn, there would be consumed in the manufacture of these cars less than 9 per cent of the corn raised in this country in that year. I refer here to the grain and not to the entire weight of the crop.

This is a great steel producing nation, but the weight of bone dry corn stover produced each year in six corn belt states alone is considerably greater than our entire tonnage of steel produced. Steel tonnage is 50 million tons. Corn stover is well over 59 million tons.

Also, there are 25 million dwelling houses in the United States. Each of these houses could be provided with efficient insulation for all outside walls from the utilization of one year's production of dry corn stover. In other words, we produce vast tonnages of farm crops as compared to the tonnage of many of our industrial commodities.

Imagine the scene at your breakfast table. It is likely that each day for years you have looked at the same toaster, looked through the same glass windows, used the same tableware, but every morning there are new slices of bread in the toaster, new eggs on the plate (and vest), and new cream in the pitcher. Have you ever stopped to think what it means in total annual production when goods are consumed daily rather than annually or by decades?

Practically every economic group in this country has been devoting most of its energies during the past ten years to looking through nicely tinted, strongly magnifying glasses at the grass across the fence, in the other fellow's pasture. Agriculture does face many problems, but agriculture has some advantages. Let us take a look at marketing. There is practically no manufactured article today which can be put on the market at a stated price, either high or low. Buyers must be found and the price is determined by the desire and willingness of the buyer to trade his labor for the labor of the man who made the article. In looking down the chemurgic road, farm people will learn that the market for a finished product sent down that road must be discovered, developed, and secured, competing with everything else for which people spend their money.

FARMERS' POSITION ESSENTIALLY COMPETITIVE

We are a people of great wants. A shortsighted person may say that is one of our faults. Instead it is one of our greatest blessings. The standard of living of a people is measured by the degree to which they have those things without which they are unhappy. With our proven ability in this country to produce more things than people need to sustain life, we have developed the ability to consume, which in turn supports production. For most manufactured goods there may be said to be an almost limitless demand. If farm chemurgy can partially be responsible for creating new desirable things from farm products, the farmer will supply the raw materials; the manufacturer will process, fabricate, and distribute; and we will all utilize.

But where is the place of the farmer in this picture? Is it his job only to produce? Turn back the pages of history for one hundred years in this country and take a look at farming and manufacturing. In most places in 1840, you will find that the farm was a more comprehensive enterprise than the factory. There was more capital invested, more labor and power employed, and the value of products was greater than that of the multitude of small industries which had sprung up in the villages all over the land.

But many of these small factories did not stay small. Some grew larger, more disappeared. The life or death of these small factories was determined almost entirely by the consumer. The user of boots or clothes or axes determined which small industry would expand and which would fail. Those who served best and who understood best the desires of their customers were those who continued in business.

So today we have large and small industries. Many of the small industries of today will be the large industries of tomorrow.

There are those in this country today who are determined to cast the American farmer from a single mold. He will till a limited number of acres. He will be self-

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A paper presented before the seventh annual chemurgic conference, at Chicago, Ill., March 26, 1941. Abridged. Author: Assistant general sales manager, Caterpillar Tractor Co.

sufficient. He will own his farm, clear of all debt, as though the use of borrowed capital was sinful. He will look for guidance to a higher power—and I am not thinking here in religious terms. There are somewhat over six million farms in the United States and roughly ten million people engaged in operating these farms. Is it logical to expect that 60 per cent of the people engaged in farming are equally capable of management, have equal ability in determining what and when to plant, how to care for livestock, what equipment to buy and not to buy, when to borrow money and how to utilize it, and make all of the other hundreds of decisions which must be made on any farm?

Without doubt management is the greatest single influence in determining the success or failure of an industrial enterprise. Industry, in essence, consists of the proper managing of labor, power, and machinery and the use of raw materials to the end that a product is well made and distributed. The same factors work in agriculture, except that the burden of distribution is less of a problem, while the job of production is usually more of a problem because of the unpredictable influence of weather, insect and animal pests, and diseases.

DECENTRALIZATION OF INDUSTRY BY FARM PROCESSING OF FARM PRODUCTS

Decentralization of industry has been widely discussed. Those who sponsor this move point to the better living conditions found away from industrial centers, and a supply of labor made up of those who wish to work either part time away from their farms or may wish to find total employment away from the farm. In speaking of the decentralization of industry, most people visualize a large industrial organization plucking out from its being a small segment and literally setting it down in some area where it can function as a unit, its products being sent to the parent plant for incorporation into the finished product.

If agriculture is given the opportunity to develop good management, and no handicap is placed in the way of a man who has energy, imagination, and desire to assume greater responsibilities, then it is likely that another type of decentralization of industry will develop, and that is the developing of small industrial enterprises on the farm.

Chemurgy could well consider as one of its principal goals that of encouraging and giving advice and information to those who wish to do further processing of the raw materials now produced in surplus on our farms. Some of this help should be along the lines of standardization of the product so the user may know more exactly that the characteristics of the article he buys will be uniform. Agriculture now has developed marketing organizations where producers work cooperatively. There is a place for this type of activity in the marketing of the product of a number of small farm enterprises producing identical chemurgic materials.

Many families now living on farms are burdened with the full responsibility of farm management and are encountering great difficulties in meeting their obligations. Who is going to say that they would be less happy if employed on a farm-factory well housed, assured of food and income, relieved of the responsibilities of management, yet enjoying all the values of rural living?

Some people seem to think that it is disgraceful to work for another and that one person has no right to direct the work of another. Anyone who has engaged in group activities knows that where some people are unhappy without responsibility, there are many others who are just as unhappy if they are given more responsibility than they wish.

Agriculture in this country is in danger of "statistical suffocation". Farm activities are being totaled, averaged, added, and subtracted to death. Total production of crops and all farm expenditures are fed into a hopper and out comes the cost of producing a bushel of wheat or corn. Did you ever look at the actual cost of production figures as carefully kept on many farms? If so, just note the great spread in the cost of producing a bushel or a pound of product, even on neighboring farms. Try to get the reason. Compare size of farm, soil type, or tillage practices. Certainly they are factors, but the quality of management is the greatest factor.

CHEMURGY AND LOW-COST FARM PRODUCTION

Farm chemurgy must reckon with the variable of farm management. Industry will use farm products as raw materials almost in proportion to the cost of the agricultural products as compared to products from other sources. Don't forget there is competition between different agricultural materials as well as between agricultural and nonagricultural materials. That is as it should be. Competition in industry is the spur that develops new and better products, lowers cost, and gives greater service to the consumer. So do not overlook the fact that farm commodities can be sold at a good profit by certain growers at a unit price which is below the cost of production of other growers. Here is a problem for solution. All of our farm crops cannot be grown by the low cost producer.

Can we not, however, accept as fundamental the objective of producing our farm crops at the lowest possible cost. This will increase both the food and nonfood utilization. Given low cost, industrial use of farm products will grow. More men will be employed in processing, manufacturing, and distributing. This will benefit the farmer, whether this employment is on his farm or in the city. More employment in this country means more money spent for food, clothing, and shelter. The farmer stands to gain through a better market for his meats, dairy products, fruits and vegetables; the opportunity to utilize on his farm now unused time, power and equipment, and the additional income from a market for his products through industrial use.

As in all enterprises, a small addition to the gross income often adds materially to the profit. Thus, even though chemurgy may not be responsible for the addition of markets for huge quantities of farm products, if chemurgy can add a small per cent to the gross income of many farmers, this added income will mean much in the way of increased buying power and a better life in rural America.

Applied Science

SCIENCE studied and taught without regard to possible practical applications has been called pure science, and some people have inferred therefrom that applied science is necessarily impure, tainted, contaminated, and otherwise represents a lower scale of human endeavor by reason of its association with the bread and butter interests of life.

That is a matter of viewpoint, and not too important. The important thing about applied science is that it can be and generally is practiced with the same strict regard for accuracy of equipment, method, results, and conclusions for which pure science is noted.

In fact, applied science might well be defined, and encouraged, as an extension of pure science to include a scientific outlook on the significance of natural laws and phenomena to human life, pursuits, and objectives.

NEWS

A.S.A.E. Annual Meeting Attractions

IN GENERAL plan, the annual meeting of the American Society of Agricultural Engineers at Knoxville, Tenn., June 23 to 26, will be similar to last year's meeting, with concurrent technical division sessions the first three mornings, the general sessions and special events in the afternoons and evenings, and the College Division program the last day.

For convenience of members arriving early, the registration headquarters will be open Saturday afternoon and evening, June 21, and all day Sunday, June 22.

GENERAL SESSIONS

Features of the opening general session, Monday afternoon, June 23, will be an address on "Some Southern Agricultural and Industrial Accomplishments," by Dr. M. Jacob, dean of agriculture, University of Tennessee; the annual address of the president of the American Society of Agricultural Engineers, by E. E. Brackett; and "Some Objectives and End Results of T.V.A.," by Dr. H. A. Morgan, chairman, Tennessee Valley Authority.

Wednesday afternoon's general session will feature addresses by three members of the A.S.A.E. R. H. Driftmier is to speak on "Trends and Characteristics of Southern Agriculture." L. F. Livingston, in the role of a technical prophet, will offer "A Glimpse into Tomorrow for the Builder." S. P. Lyle has been chosen to develop the subject of "Agricultural Engineering in National Defense." The annual business meeting is to be held at the close of this session.

FARM STRUCTURES

Home improvement, economic considerations, and extension methods are dominant in the Farm Structures Division program.

Structures bridge the gap between sanitation as a mere word and sanitation as a practice. The first session, Monday morning, June 23, appropriately opens with a paper on "Improving Farm Sanitation in the South," by Hugh L. Roberts.

Actual farm building practice lags behind technical progress due to personal factors. Some steps toward correcting this situation will be outlined in papers on "The Kentucky Farm Building Extension Program for Rural Carpenters," by J. B. Brooks, with discussion by C. H. Van Vlack, and "Increased Utilization of Farm Labor in Repair and Construction of Farm Buildings," by E. L. Arnold.

Lack of maintenance and the changing face of agriculture have created "New Problems in Farm Building Rehabilitation," which will be discussed by F. J. Hallauer. Wallace Ashby, chairman of the Division, will preside at this session.

Analysis relating human objectives to technical means is particularly suggested in subjects scheduled for the second session Tuesday, June 24. These are "Economics of Farm Buildings and Their Relation to Farm Management," by J. A. Slipher; "Farm Improvements—Tombstones or Tools," by D. Howard Doane; and "A National Program for Farm Building Improvement," by E. W. Lehmann. G. B. Hanson, vice-chairman of the Division, will preside.

A miscellany of subjects of timely interest scheduled for the third session, Wednesday morning, includes "Use of Models in Extension Work in Farm Buildings," by H. W. Dearing; "Adequate Housing with Limited Income," by Deane G. Carter; "Role of Fresh Air in Poultry Raising," by Dr. M. W. Emmel; "Better Living in Southern Homes," by A. C. Hudson, Jr.; and "Evaluation of Electrical Household Equipment," by P. B. Potter.

RURAL ELECTRIFICATION

Technology—the facts and applications of natural science which determine what is physically possible in rural electrification, and which have an important bearing on what may be economically and socially practicable—will be the major interest in the Rural Electric Division program.

In the improved control and use of heat which makes heating by electricity practical for certain applications, three studies to be reported Monday morning are "Propagating Sweet Potato Plants with Electric Heat," by G. H. Stewart; "The Economic Spacing of Chicks under Electric Brooders," by J. E. Nicholas; and "Heating Studies of a Homemade Outdoor Brooding Unit," by J. B. Greiner.

A.S.A.E. Meetings Calendar

June 23-26—Annual Meeting, Knoxville, Tenn.

Sept. 29-Oct. 1—North Atlantic Section, Jackson's Mills, W. Va.

December 1-3—Fall Meeting, Stevens Hotel, Chicago.

As a new aid in introducing technical possibilities to farm practice, R. H. Gist and R. W. Godley will report on "A State Rural Electrification Laboratory in the Extension Program." J. P. Schaenzer, division chairman, will preside.

One approach to farmstead utility engineering problems will be presented in a paper on "The REA Farmstead Plumbing Program," by J. R. Cobb. This will open the Tuesday morning program. "Butter-and-egg" interests will dominate the balance of the session, with papers on "The Direct Expansion System of Cooling Milk on Dairy Farms," by R. L. Perry; "Artificial Lights for Egg Production," by J. Roberts; and "Cooling Eggs at the Farm and Grading Stations," by J. W. Weaver, Jr. A. V. Krewatch, vice-chairman of the Division, is scheduled to preside at this session.

A motor use in the development stage will be covered in "Irrigation Pumping with Electric Power," by Aldert Molenaar, in the Wednesday morning session. "The Electric Fence" is to be discussed by Chas. F. Dalziel from the standpoint of indications brought to light by him and others in electrical engineering research at the University of California. Another application of electricity for its direct biological effects is "Soil Pasteurization by Electricity from a Constant-Current, Series Lighting Transformer," to be presented by Santiago R. Cruz. Climatically and nutritionally speaking, the South is refrigeration country, as will be attested by P. T. Montfort in a paper on "Equipment for Freezing and Storing Foods on the Farm."

Technical committees of the A.S.A.E. in the rural electric field will report their progress briefly in these sessions.

SOIL AND WATER CONSERVATION

Mechanical aids to soil and water conservation will be appropriately emphasized in the opening session of this Division. From the standpoint of efficiency in mechanical farm operations, R. L. Copely will present "An Improved Row System for Terraced Fields." M. L. Nichols and R. B. Gray are scheduled for a contribution on "Farm Machinery and Soil Conservation," presumably covering design and use of machines both for instituting soil and water conservation measures and in routine farm operations favorable to conservation. A report on "Facilities and Activities of the U.S.D.A. Tillage Machinery Laboratory," by R. M. Merrill, presages increased usefulness of this agency in mechanical research related to conservation. "Terrace Construction with Small Equipment," by Ed. A. Schlaudt, will cover an angle of practice subject to engineering refinement. A new viewpoint on "Why Soil and Water Conservation?" is to be presented by W. M. Landess. I. D. Mayer, division chairman, will preside.

Concentration on the physical science of soil and water conservation engineering characterizes the second session of the Division. Contributions scheduled are "Runoff Rates from Corn, Wheat, and Hay Plots on 5 to 25 Per Cent Slopes," by James H. Lillard; "Research Studies of the Hydrologic Division, Soil Conservation Service," by C. E. Ramser; "The Design of Plot Experiments for Measurement of Runoff and Erosion," by A. E. Brandt; "Big Waters on Little Streams," by Albert S. Frye; and "Report of Committee on Hydrology," by H. S. Riesbol. Mr. Riesbol, as vice-chairman of the Division, is also to preside at this session.

Distinctly on the water conservation side are papers on "Construction of Farm Ponds for Livestock Water Supply," by R. C. Shipman, and "Controlled Drainage of the Peat Soils of the Northern Everglades," by Lewis A. Jones and B. S. Clayton, on the third session schedule. Water as a nuisance item will be discussed under the title of "Flood Control," by R. L. Stevens. Soil angles to be covered in this session include "Soil Rehabilitation and Erosion Control," by B. G. DeWeese; "Plowing for Terrace Maintenance," by John M. Downing; and "The Effect of Strip Cropping and Clean Cultivation on Erosion," by E. G. Diseker. Basic data agricultural engineers would like to have, but which is not yet available, as revealed by a questionnaire, will be indicated by R. B.

Hickok in a report on "A Survey of Requirements for Hydrologic Information by Agricultural Engineers."

POWER AND MACHINERY

Cultural methods and machinery for special southern crops will be paraded in review in the opening session of the Power and Machinery Division. The crops and speakers: "Lespedeza," by E. K. Rambo; "Blue Grass," by J. B. Kelley; "Tung Nuts," by W. C. Howell; "Peaches," by G. B. Nutt; "Sorghum Cane," by J. H. Neal; "Peanuts," by R. H. Driftmier; "Sugar Cane," by H. T. Barr; "Apples," by C. E. Seitz; "Rice," by D. G. Carter, and "Mung Beans," by L. E. Hazen. A. W. Turner, division chairman, will preside over this session.

Cotton, the symbol of southern agriculture, will be brought up to date from the standpoint of agricultural engineering problems in its production, in two Tuesday morning papers, "Recent Developments in Cotton Ginning," by C. A. Bennett, and "Machinery for Cotton Production," by Wm. E. Meek, Jr.

The research problem of efficient production of engineering data will be dealt with in the same session in terms of "Plot Technique in Methods of Testing Field Equipment and Practices," by A. E. Brandt.

Lubrication, as an item of perennial interest in the engineering of farm operating equipment, has been given a place in this session by reason of new information to be presented by C. W. Smith in a report on "Results of Research Work on Oil Filters." "New Developments in Tractor Engine Fuels and Lubricants" is the title of a paper by C. N. Hinkle.

Sweet potatoes are growing, not only from little ones into big ones, but in the broader sense of their economic importance as a southern farm crop; and to an extent which has commanded a session of the Power and Machinery Division devoted to their production methods and utilization. This will be held Wednesday morning, June 25.

COLLEGE DIVISION DAY

A combined session of the whole College Division will be held Thursday morning, June 26. Industrial interests in the work of college agricultural engineering departments will be distinctly represented in the first two subjects. "Farm Safety Education" is to be discussed by Frank Kranick. Arthur W. Turner will introduce "The Agricultural Engineer—A Sales Engineer for the Farm Equipment Industry." H. H. Sunderlin, F. A. Wirt, and other representatives of farm equipment manufacturers are to contribute to this discussion.

S. A. Witzel, Wallace Ashby, Henry Giese, and J. D. Long will contribute to a symposium on "Training Agricultural Engineers in Farm Structures for a Nation-wide Farm Building Program."

"Lessons Learned from National Defense Training for Rural Youth," will be reported by C. H. Christopherson, G. E. Freeman, J. K. Coggin, and others.

"Interest in an Agricultural Engineering Data Book," as evidenced by replies to a questionnaire addressed to members of the A.S.A.E. last winter, is to be reported briefly by Ralph A. Palmer.

Dr. J. B. Davidson will report for the Committee on Curriculum Rating. David S. Weaver, chairman of the College Division, is scheduled to preside.

Separate meetings of the research, extension, and resident instruction groups will be held in the afternoon.

E. A. Silver, chairman of the Committee on Research has scheduled a discussion of research objectives, to be led by W. D. Ellison.

S. A. Anderson, general chairman of the Committee on Extension, has arranged a program including contributions on "A Survey of Visual Aids Used by Extension Agricultural Engineers," by V. S. Peterson, and a "Report of the Subcommittee on Rural Electrification," by E. T. Swink.

H. E. Pinches, chairman of the Committee on Resident Instruction, offers a program including a symposium on "What Should We Teach in Rural Electrification?" with contributions by members of the committee; a paper on "Instruction in Dairy Engineering in the Land-Grant Colleges," by Dr. E. G. McKibben and Harold D. White; and reports of the Subcommittees on Soil Conservation and Rural Electrification by Donald Christy and F. E. Price, respectively.

STUDENT GROUP PROGRAM

For the agricultural engineering students who will attend the meeting, officers of the National Council of A.S.A.E. Student Branches have arranged a special program covering mornings of all four days of the meeting.

"New Developments and Opportunities for Young Agricultural Engineers" is the general topic for the opening session. Speakers will cover subject matter branches of agricultural engineering work as follows: "Machinery," R. H. Driftmier; "Structures," J. D. Long; "Irrigation and Drainage," F. E. Price; "Electrification," Geo. W. Kable; and "Soil and Water Conservation," W. M. Hardy.

Tuesday morning will be devoted to reports and discussion of student branch activities, with contributions from each Branch represented, and talks by a few faculty advisers.

A technical session on "New Problems and Recent Developments in Agricultural Engineering" is scheduled for Wednesday morning. It will be conducted as a series of panel discussions, with students from all branches represented participating. Discussions and contributing branches have been divided on a basis of eight general agricultural areas.

On Thursday morning a round-table discussion of student branch problems will be followed by the annual business meeting and election of officers of the National Council of Student Branches.

A softball game, picnic, and mixer for students and faculty members has also been scheduled for Monday at 4:30 o'clock.

ENTERTAINMENT AND SIGHTSEEING FEATURES

High point of every A.S.A.E. annual meeting, socially, is the annual dinner, to be held this year on Wednesday evening, June 25. On the lighter side, with a minimum of speechmaking and a maximum of informal pleasantry, this event has become a symbol of the spread of gracious living to which agricultural engineering contributes. The program in detail has not yet been announced, but is being carefully planned to fulfill its function.

Another featured event this year will be a trip, Tuesday afternoon and evening, to the Smoky Mountain National Park, southeast of Knoxville.

Other entertainment will include that planned for ladies and children, and will reflect the hospitality of the Knoxville area.

In summary, the meeting program has been planned to give a maximum of individual choice to make the most of personal interests in the technical program, professional features, personal contacts, sights to be seen, recreation, relaxation, and other opportunities of the occasion.

American Standard Abbreviations Published

ABBREVIATIONS for Scientific and Engineering Terms were approved by the American Standards Association in March 1941 and have now been published as an American Standard. Organizations sponsoring this standard were the A.A.A.S., A.I.E.E., A.S.C.E., A.S.M.E., and S.P.E.E.

Work toward this standard was started in 1927. An American Tentative Standard was approved in 1932, and with subsequent revisions, was developed into the standard now in effect.

According to the subcommittee in charge, it was guided by current good usage, trends in use of abbreviations by technical publications, and economy of space, typesetting cost, and readers' time. The standard includes introductory notes in which abbreviations of words are distinguished from symbols. Abbreviated terms of measurement are indicated to be used in text only in connection with numerals. Abbreviations are identical for singular and plural forms. Use of conventional signs for abbreviations is discouraged. Periods following abbreviations are used only in exceptional cases.

Abbreviations are given for some 270 technical words and word combinations, for use where familiarity with the terms on the part of most readers permits a maximum of abbreviation. It is recognized that longer abbreviations or spelling out may be more desirable from the standpoint of readers not intimately familiar with the terms used.

AGRICULTURAL ENGINEERING, in its abbreviation practice, has been following the former tentative standard quite closely, and will do the same with the approved standard. The varied technical training of our readers will be recognized in applying the principles and practices outlined in the standard. Where an abbreviation that might be confusing to some of our readers is used, we will continue our practice of spelling out the word or words in parentheses following the first use of the abbreviation in each article in which it appears. We believe that the period can also be eliminated without confusion following the abbreviations for "inch" and "barometer," and will hold with some other technical publications in this respect in recognition of a trend which seems due to lead this to be adopted as standard practice in the near future.

The Standard can be obtained from the American Standards Association, 29 West 39th St., New York City, at 35 cents per copy.

Southwest Section Reflects Active Interest

NEARLY 100 agricultural engineers from the states of Texas, Oklahoma, Arkansas, and Louisiana attended the Southwest Section meeting of the American Society of Agricultural Engineers at Dallas, Texas, April 11 and 12.

F. R. Jones was elected chairman of the section; Howard Matson, vice-chairman; and E. B. Doran, secretary.

Speakers from outside of the section area were E. E. Brackett, president of the A.S.A.E., and L. J. Fletcher, a past-president of the Society.

The Section voted to meet at Texarkana in April 1942.

Fletcher in New Position

A NEWLY created training and public relations department in the Caterpillar Tractor Company will be headed by Leonard J. Fletcher, according to a recent announcement by the Company. In this capacity he will direct the organization's factory training courses, foremen's conferences, and other employee training and general public relations work.

Mr. Fletcher joined the Company in 1927 as agricultural sales manager, and later was made assistant general sales manager. He graduated in agricultural engineering from Iowa State College in 1915, became a member of the agricultural engineering division of the University of California in 1916, and had served as head of that division for six years when he joined the Caterpillar organization in 1927.

A member of the A.S.A.E. since 1918, he has been a continuously active worker in the Society, serving it in numerous capacities including that of chairman of the Power and Machinery Division in 1927-28; president of the Society for the year 1931-32; and its representative on American Engineering Council for several years. In the latter capacity he was made chairman of some of its important committees and also served as treasurer and a member of the executive committee of Council. His service to the Society is further marked by frequent instances of thoughtful consideration and activity in its interest as an individual member, in addition to taking care of his official responsibilities.

Frank Zink Joins F.E.I. Staff

THE Farm Equipment Institute, Chicago, announces that Frank J. Zink (Member A.S.A.E.) has joined its headquarters staff.

Mr. Zink is an agricultural engineering graduate of Iowa State College, of the Class of 1924. After graduation he was first employed as assistant engineer in the Iowa Engineering Experiment Station, in charge of the Station's field laboratory at Garner, on the relation of electricity to agriculture. From here he was transferred to Iowa State College, where he continued in research and extension work in rural electrification.

In 1929 he accepted a position with the Westinghouse Electric and Manufacturing Company, in field work with utilities, rural service engineers, and farm equipment manufacturers in the Midwest. He left this work in 1930, however, to become associate professor of agricultural engineering at Kansas State College.

For the Society year of 1935-36, he served as chairman of the Power and Machinery Division. During 1936 he accepted a position as research engineer with the Allis-Chalmers Manufacturing Co., and since early in 1940 has worked with other farm equipment manufacturers.

Hanson in New Position

ON May 1, G. B. Hanson took up his new position as sales manager of the Rilco Laminated Products Co., Albert Lea, Minn., where he will be located. This company is an affiliate of the Weyerhaeuser organization; it manufactures laminated wood rafters, arches, etc.

Prior to accepting this new position Mr. Hanson was agricultural engineer of the Portland Cement Association and is well known to A.S.A.E. members, especially those of the farm structures group. He is currently vice-chairman of the Farm Structures Division.

Personals

Harold T. Barr and *Wiley D. Poole* are joint authors of three publications recently made available by Louisiana State University. Louisiana Bulletin No. 331 is on "Precooling of Strawberries" and No. 332 covers "Precooling and Drying of Washed Irish Potatoes." The third is a mimeograph on "Details for Constructing Fan Units for the Cooling and Drying of Irish Potatoes."

A. M. Goodman has recently had published as Cornell Extension Bulletins, No. 451 on "Homes for Laying Hens," and No. 453 entitled "The Air-Cooled or Common Apple Storage and Its Management."

O. K. Hedden and *R. M. Merrill* report on "Experiments in the Use of Vapor-Spray Equipment" in Circular No. 598 of the U. S. Department of Agriculture.

W. C. Hulburt has recently accepted appointment as assistant agricultural engineer at the Beltsville Research Center, U. S. Department of Agriculture, Beltsville, Md., having resigned as instructor in agricultural engineering at the University of Arkansas.

Mack M. Jones and Robert P. Beasley report on "Combine Harvesters in Missouri," in Missouri Agricultural Experiment Station Bulletin 426.

W. A. Junnila is senior author of Washington State College Popular Bulletin No. 160, on "Electric Pig and Lamb Brooders."

C. F. Kelly reports on "Temperatures of Wheat in Experimental Farm-Type Storages," in Circular No. 587 of the U. S. Department of Agriculture.

Thos. A. H. Miller is senior author of "Foundations for Farm Buildings," in publication as U.S.D.A. Farmers' Bulletin No. 1869.

George E. Mullin, Jr., manager, farm sales section, appliance and merchandise department, General Electric Company, has completed an extensive study of the farm market and has concluded that there is a potential market of 120 million dollars for electrical appliances in farm homes in 1941, and is directing an intensive advertising and promotional campaign at this market.

L. H. Schoenleber recently joined the agricultural engineering staff of Kansas State College as assistant professor of agricultural engineering. He was previously assistant agricultural engineer, division of research, U. S. Soil Conservation Service.

Necrology

William Arthur Foster, associate professor of rural architecture, University of Illinois, passed away April 12, at Urbana, after entering a hospital the previous day for a week-end rest. He was nearing 57 years of age.

Mr. Foster was an architectural engineering graduate of Ohio State University, also held a bachelor's degree in education, had several years of experience as a teacher of industrial and vocational subjects in public schools, worked a few years as draftsman in the architect's office of Ohio State University, went to the Iowa Agricultural Experiment Station as assistant in agricultural engineering, and progressed in his chosen field of farm structures in subsequent positions with the University of Georgia and the University of Illinois. He was awarded the professional degree of architectural engineer in 1923.

In collaboration with Deane G. Carter, he was author of a well-known college text on farm structures, now in its third edition. He was also joint author of a book on "Home Architecture." In addition, he had written numerous bulletins and was a regular contributor to the farm press.

He was a registered architect in Ohio, and the architect of residences built in Ohio, Pennsylvania, Iowa, and Illinois, and of one or more university buildings at Iowa State College, the University of Georgia, and the University of Illinois.

In the ASAE, of which he became a member in 1917, he served as vice-president in 1924-25 and as chairman of the Farm Structures Division in 1925-26. He was also a member of the American Institute of Architects, the Society for the Promotion of Engineering Education, Phi Kappa Phi, Gamma Sigma Delta, the I.O.O.F., and an elder in the First Presbyterian Church of Urbana. Funeral services were held in that church and later at the place of interment, the I.O.O.F. cemetery at Mapleton, Pa.

Mr. Foster is survived by his widow; a son, George; and two daughters, Marie, and Mrs. J. M. Carrithers.

National Fire Protection Association Meeting

DURING the week of May 12 to 16 the National Fire Protection Association will hold its forty-fifth annual meeting at Toronto, Ontario.

Two half-day sessions and some papers on other sessions will be devoted to the special fire prevention and control problems of defense. Some other program subjects of more or less interest to agricultural engineers include classification of electrical fires, current developments in arson control, control of heating hazards, fire prevention and cleanup campaign, new developments in carbon dioxide protection, dust explosion hazards, flammable liquids, fireproofing and preservative treatments, farm fire protection, and storage of combustible fibers.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the April issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Frederick L. Browne, senior chemist, U. S. Forest Products Laboratory, Madison, Wis. (Mail) 119 Ash St.

James A. Dilts, instructor, agricultural engineering department, Oklahoma A & M College, Stillwater, Okla.

Arthur King, specialist in soils, extension service, Oregon State College, Corvallis, Ore.

S. A. McMillan, regional farm management specialist, Farm Security Administration, U. S. Department of Agriculutre. (Mail) 835 Clermont Ave., Dallas, Tex.

R. O. Pierce, acting extension engineer, agricultural engineering department, University of Nebraska, Lincoln, Nebr. (Mail) 5335 Huntington Ave.

P. D. Rodgers, junior agricultural engineer, Virginia Polytechnic Institute, Blacksburg, Va. (Mail) Box 287.

A. Kaye Rollins, inspector, Farmers Mutual Reinsurance Assn., Grinnell, Iowa.

M. M. Samuels, chief, technical standards division, Rural Electrification Administration, U. S. Department of Agriculture, Washington, D. C.

TRANSFER OF GRADE

C. F. Kelly, associate agricultural engineer, Farm Structures Research Division, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture. (Mail) 6900 Dartmouth Avenue, College Park, Md.

Student Branch News

TEXAS

By Joe W. Autry

SPRING months have brought increased activity to the Texas A. & M. Student Branch of the ASAE. Although most of the later meetings have been confined almost entirely to business, we have been fortunate in having some programs provided by farm implement companies.

At one of the earlier meetings of the second semester the society was shown two films furnished by the Minneapolis-Moline Power Implement Company.

For our meeting on April 3, a program was presented by a delegation of twelve representatives from the Houston branch of the International Harvester Company, headed by Mr. L. M. McWhirter, branch manager. The manager of each department within the branch and several sales representatives were present. Each man in the group made a short talk on the operations and organization of his department and its place in the general company organization.

Highlighting the year's activities, the Branch presented on April 18 its sixth annual "Barnyard Frolic", a costume dance held on the top floor of the agricultural engineering building. This space is used regularly as a farm machinery laboratory, but on the night before the dance everyone in the organization helped to move out the machinery and get the floor ready for the dance. Proceeds from the dance are to be used to send student delegates to the national ASAE meeting and to the Industry Seminar.

Another activity of the Branch during the second semester was its participation in "Ag Day" held May 3. Our exhibits, showing various phases of Agricultural Engineering, aroused considerable interest among visitors to the College. Committees of members were appointed to arrange the exhibits and to conduct the various demonstrations.

The power and machinery exhibits included both old and modern types of farm machines to depict the development of tractors, plows, and grain harvesting machinery from the earliest types to the present. Special tractor and engine testing equipment was shown and demonstrated.

Land reclamation and irrigation exhibits included displays of terracing equipment, water measuring devices, models of terraced farms, and demonstrations of irrigation systems.

The farm buildings and equipment display included water systems; hydraulic rams; electric lighting, heating, and refrigeration systems; and models of farm buildings, along with various materials of construction.

Farm shop equipment for wood and metal work, rope making, leather work, and machinery repair was also displayed.

SASKATCHEWAN

By E. A. Olafson

ON Monday evening, March 17, the Branch played host to faculty members and Saskatoon implement men and their ladies, on the occasion of the official opening of the new agricultural engineering laboratory which was added to the engineering building last fall.

Don Trapp, president of the Branch, was in charge of arrangements. He spoke of the pride of the agricultural engineers in their department and he pointed out that Saskatchewan is the only university in Canada which graduates agricultural engineers.

In officially opening the new laboratory, Dr. W. C. Murray, president emeritus of the University, spoke humorously of early university days here and commended the work being carried on by the agricultural engineering department under the direction of Prof. E. A. Hardy.

Prof. Hardy outlined the history of the growth of the department. Many former students have expressed their gratitude for the start they got in former courses which Prof. Hardy considered were very crowded. He hoped that even better results would be obtained from the wealth of equipment available for study and made possible by the increased floor space, which now covers one-half acre.

In the final meeting of the year, plans were made for the completion of the Farm Equipment Institute Cup report. Possibilities of representatives of this Branch attending the A.S.A.E. meeting in Tennessee were also discussed, and it is hoped that some members will be able to attend. Don Trapp, president, spoke highly of the benefits to be derived from such an experience.

Jack McTavish left on March 4, and is attached to the R.C.O.C. at Kingston, Ont. Don Trapp and Al McKinnon left April 10 to join the Civil Service in Toronto, Ont., as aircraft inspectors.

Officers elected for the 1941-42 term were honorary president, R. P. Frey; faculty advisor, E. A. Hardy; president, Ellaf Olafson; vice-president, Keith Byrnes; secretary-treasurer, Jim Bayes; scribe, John Nelles; and executive committee, Cameron McKay and Donald Cram.

VIRGINIA

By Austin Nelson

OUR reading of reports in AGRICULTURAL ENGINEERING of the activities of A.S.A.E. Student Branches in other states makes us proud to be associated with them.

The agricultural engineering department was established here at V.P.I. in 1919 by C. E. Seitz, who is still the department head. Our student branch of the A.S.A.E. has been relatively small, but it has steadily grown in membership since its beginning. This year the graduating class reaches a maximum of approximately twenty-five seniors to graduate in June. There are about seventy-five students enrolled in the agricultural engineering curriculum here.

Our meetings are held weekly. To maintain popular interest, student or visitor speakers are chosen for each meeting. Occasionally this procedure is varied, and movies pertinent to our studies are shown. Several times a year socials and smokers are held.

THEY'VE DUG A "PANAMA CANAL" SINCE NEW YEAR'S DAY!

Moving frozen Maryland mud in January for an expansion of the Glenn L. Martin Plant.

IN THE dead of winter, came the urgent call to mobilize power and equipment—to do the groundwork on Hemisphere Defense on hundreds of fronts.

For men don't encamp—planes don't fly—new plants don't produce materiel—new highways and railroads don't carry freight—till earth-movers have done their jobs!

Every condition had to be met—from cypress swamps of Florida to the frost-bound arctic tundra of Alaska. From Coast Range rock to sticky, soggy Missouri gumbo to East Shore sand. There was work to be done to overtax the strength of half a million mules and many thousands of men.

And ready to do this huge job were thousands of sure-footed, untiring "Caterpillar" Diesel Tractors—experienced men to operate them—directed by the most highly skilled earth-moving men in the world; U. S. contractors and engineers! Since New Year's Day, 1941, this equipment has moved approximately 500,000,000 cubic yards of earth. More than was moved to construct the Panama Canal!

CATERPILLAR TRACTOR CO., PEORIA, ILL.

CATERPILLAR *Diesel*

REG. U. S. PAT. OFF.

DIESEL ENGINES   TRACK-TYPE TRACTORS   TERRACERS

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the addresses indicated.

A LABORATORY STUDY OF THE DRAINAGE REQUIREMENTS OF SWEET CLOVER, *P. W. Manson.* Minnesota Sta. Tech. Bul. 144 (1940), pp. 28, figs. 17. Experiments here described showed that biennial white sweet clover can be satisfactorily grown in the laboratory under artificial light if the heat developed by the lamps is intercepted by a water filter placed between the lamps and the plants. The drainage experiments were carried out in this way.

The growth of sweet clover was definitely stimulated by good drainage, but the plant was grown successfully on soils known to be drained too poorly for satisfactory results with many farm crops. The growth of young sweet clover, from 5 to 7 in high, was not retarded by a water table only 3 in below the surface for periods up to 2 weeks if afterwards the ground water was lowered. If continuously grown on a 3-in water table, the matured crop required a growing period to produce a given yield 50 per cent longer than that required when the water table was lowered sufficiently to permit a normal rooting depth for this plant. A stand of young sweet clover, from 8 to 9 in high, was not killed when the water was raised to within 1 in of the surface but continued to grow at a much reduced rate. Water brought above the surface caused the plant tissue to break down within 2 weeks. Sweet clover was found so water tolerant that no great difference in growth and yield between drainage depths of 18 and 27 in could be detected. Sweet clover flooded for 1 day after cutting and then drained at the rates of 0.25, 0.5, and 1 in per day showed marked increases in rate of growth and yields with the increase in rate of drainage through 30 days.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE IDAHO STATION. (Partly Coop. U.S.D.A.) Idaho Sta. (Moscow) Bul. 236 (1940), pp. 27-33, figs. 2. Land reclamation and conservation research have been continued by H. Beresford, J. P. Bonner, M. R. Kulp, J. C. Marr, J. L. Toevs, and W. Watson; vegetable-seed threshing studied at Parma by Beresford, C. F. Dietz, E. N. Humphrey, and G. W. Woodbury; observations upon beet harvesting machinery made by Beresford and Humphrey; mechanized dusting for pea weevil found to be promising by Humphrey; and varied research in rural electrification carried out by Beresford and J. B. Rodgers. Farm-buildings research is summarized by Rodgers.

OPERATION OF ORCHARD HEATERS, *R. A. Kepner.* California Sta. (Davis) Bul. 643 (1940), pp. 32, figs. 15. The smoke nuisance was minimized by keeping burning rates within the proper range for the type of heater used, by cleaning stacks and covers regularly and after each 20 to 30 hr of burning at the least, by the use of tight-fitting covers kept tight by careful handling, and by regulating the heaters as soon as possible after lighting, with frequent inspection to keep them properly regulated. Difficulties due to residues in the bowl-type heaters were reduced by emptying the bowls after each 50 to 75 hr of burning either by dumping the residue or burning it out, by preventing soot from falling into the bowls during the cleaning of stacks and covers, and by keeping residual oil separate from fresh oil. Automatic draft regulators were found superior to the ordinary regulator in control of the burning rate. A heater especially designed for burning residual or pour-back oil was devised, together with a heater so designed as to return part of the hot stack gases to the bowl and thereby to improve completeness of combustion. Coke heaters are considered advantageous where temperatures are relatively steady when firing is necessary, but impractical under conditions of large and frequent temperature fluctuations. A combined installation, the oil heaters for small heat demands and the coke heaters, or both oil and coke, for more severe conditions, is suggested. The chief advantages of coke heaters are lower investment costs and the elimination of the smoke nuisance.

INVESTIGATIONS IN THE SULFURING OF FRUITS FOR DRYING, *J. D. Long, E. M. Mrak, and C. D. Fisher.* California Sta. (Davis) Bul. 636 (1940), pp. 56, figs. 18. Satisfactory sulfuring was found to require (1) absorption by the freshly cut fruit of sulfur dioxide sufficient to allow for retention of enough of the preservative to maintain high quality in the fruit after normal drying and storage losses, (2) rapid drying with low sulfur dioxide loss, and (3) storage at temperatures and humidities low enough to permit retention of the sulfur dioxide. The survey and experimental work here reported are concerned with the first two of these requirements.

It was found that in a sulfur house of construction sufficiently tight to prevent drafts, vents to provide air for burning the sulfur are necessary. For the type of vents recommended, a fixed ratio must be maintained between the vent area and the surface area of the sulfur burner. Doors hinged at the side and secured with refrigerator-type latches are preferable to vertical sliding doors or those hinged at the top, when the door opening does not exceed 4 ft. For wider openings a door hinged at the top and secured against the jambs with refrigerator-type latches is preferable. The interior surfaces of sulfuring compartments should be painted with acid-resistant paints, regardless of the construction material, for durability and to tighten the structure against air leakage.

Sulfur should be burned in a clean metal pan of 10-in diameter or in clean concrete hearths of equivalent area. Unlined earthen pits are unsatisfactory. Insulated, regenerative, or forced-draft burners may be desirable for burning the poorer grades of sulfur, or those carrying contaminants. The black film or scum from some low-quality sulfurs consists chiefly of carbon or carbonaceous matter. Of the various kinds of organic materials added to test samples of a high-quality sulfur, petroleum oils were found to cause the formation of a black surface film most rapidly. This decreased the percentage of sulfur burned. By increasing the temperature of poor-burning sulfurs to cause more rapid volatilization, poor-quality sulfur could be burned completely. A good grade of refined sulfur is recommended as being more economical and less troublesome than cheaper grades. The sulfur should burn completely, leaving not more than 1 or 2 oz of residue from the standard 4 or 5-lb charge.

The temperatures at various points in the sulfur house commonly showed a difference of 20 F between ceiling and floor. Sulfuring fruit at the relatively high temperatures of 100-120 F tends to decrease absorption but increases retention of sulfur dioxide. Fruits sulfured at high temperatures, however, bleed more readily than when sulfured at lower temperatures.

The freshly sulfured fruit should be dried as rapidly as possible. Every possible advantage should be taken in the location of the drying yard, and in placing the fruit on the drying field, to maintain conditions favorable to rapid moisture evaporation. Dehydration offers definite advantages in coastal areas where climatic conditions during the drying season are unfavorable to the production of a high-quality product.

TRACTOR COSTS IN MICHIGAN, 1939, *F. M. Atchley.* Michigan Sta. (East Lansing) Quart. Bul., 23 (1940), No. 2, pp. 99-105, figs. 2. Records kept by 56 Michigan farmers, operating 60 tractors in 1939, included those of cash operating expenses, as well as the fixed charges for depreciation, interest, and shelter on the individual tractors, together with a record of the hours of use for all operations, including belt, drawbar, and custom work. Information on the acreage and production of the various crops, the number and production of the various kinds of livestock, and the receipts and expenses of operating each cooperator's farm was also obtained. There were 25 one-plow, 30 two-plow, and 5 three-plow tractors included in this study. All but 2 of the one-plow tractors were of the general-purpose type. These 2 were of the orchard type. Twenty-two of the two-plow tractors were of the general-purpose type, while 3 of the three-plow tractors were of the standard type, and 2 were of the general-purpose type. Fuel and lubricants were charged at each indivdual farmer's purchase price. Man labor used in servicing and repairing the tractors was charged at 25 cents an hour unless otherwise specified by the operator. Figures for annual depreciation and value of the tractor were furnished by the operator, and interest was charged at 6 per cent on the average value of the tractor in 1939.

Costs by size groups, sorts and quantities of fuel, hours of use by operations, hours of tractor use and tractor costs, and influence of size of farm are tabulated or shown in graphic form and are discussed. (Continued on page 198)

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Agricultural Engineering Digest

(Continued from page 196)

HURRICANE FLOODS OF SEPTEMBER 1938, U. S. Geol. Survey, Water-Supply Paper 867 (1940), pp. IX+562, pls. 20, figs. 61. This report presents records of stage and discharge for the period including the flood at about 240 stream-gaging stations, records of storage in many reservoirs, a summary of peak discharges with comparative data for other floods at about 530 measurement points, and tables showing crest stages along an aggregate length of stream channel of 1,450 mi; and records of daily observations of precipitation during the period September 12-21 at about 745 places, of more frequent observations of precipitation at about 110 places of measurement, of ocean-wave height at about 230 locations along the coast, and of water level in 31 observation wells on Long Island. The report also includes basic information in regard to the hurricane and general weather conditions associated with floods, analyses of rainfall and runoff, discussions of storage and groundwater recharge, and many other data pertinent to the floods.

SOIL AND WATER CONSERVATION INVESTIGATIONS, 1936-1939. —PROGRESS REPORT, *C. E. Seitz.* (Coop. U.S.D.A. et al) Virginia Sta. (Blacksburg) Multig. Rpt. 1 (1940), pp. [7]+54, figs. 39. The report is of a preliminary nature, dealing with a description of the problem and studies in operation with methods being used. The results will be applicable to the limestone valleys and upland region of Virginia. Adaptations of results will undoubtedly make the data of some value to the entire limestone valley extending from Pennsylvania to Alabama.

The effect of climatic factors and physical and chemical soil properties on erosion are under investigation with rotation control plats, watersheds, and through the use of artificial rainfall. Equations are presented for determining the relationship between soil and water losses and the degree of slope for corn and for wheat. Equations are also developed for relation of density of flow and degree of slope. Artificial rainfall studies indicated that 5-min applications of rainfall at an intensity of 6.6 in per hour after fertilization cause twice the phosphorus loss of an application of 3.3 in of rainfall over a 20-min period. Superphosphate applications increased plant growth and soil organic matter and brought about a better degree of aggregation in the 0 to 2 in depth. Pasture contour furrows gave a higher soil moisture content in the A and B horizons than was found under check areas.

Details on the physical instillation are illustrated by photographs. Rainfall records, including intensity and frequency as well as data from the individual studies, are presented in appended tables.

Literature Received

HOW TO TEACH A JOB, by R. D. Bundy. Cloth bound, 63 pages, 5½x8 in. This little book is intended as an aid to foremen, job setters, vocational instructors, and others concerned with teaching trade skills. It is based on experience of the author in such teaching and on the experiences of foremen and plant executives as revealed in numerous conferences on the subject, much of it in connection with present industrial training for defense production. Chapters cover looking at the problem; first, second, third, and fourth steps in teaching; lesson planning analysis; preparing the lesson; and restatement of the problem. The National Foremen's Institute, Deep River, Conn. $1.00.

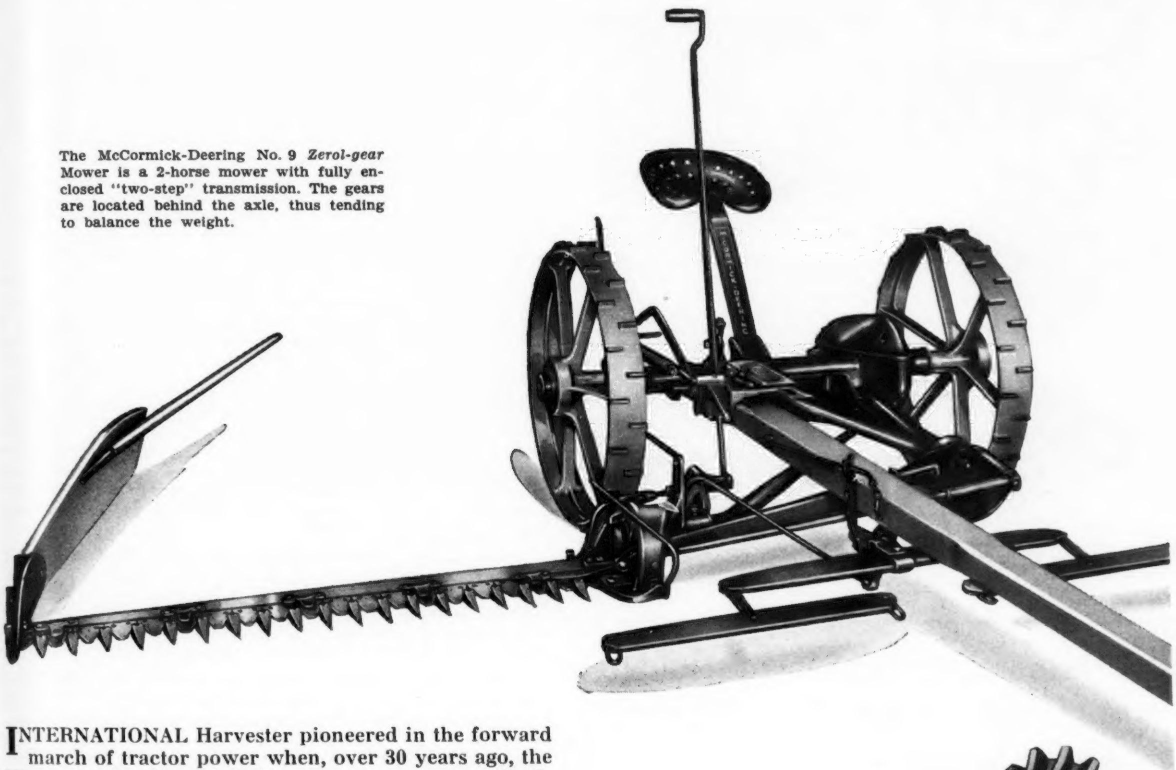
DESIGNING TIMBER CONNECTOR STRUCTURES, by J. E. Myer. Paper cover, 22 pages, 8½x11 in, 22 figures, 3 plates. This pamphlet is published as a companion booklet explaining the application of data contained in a "Manual of Timber Connector Construction" by the same author. It contains information on the types and uses of timber connectors, conditions affecting connector loads, factors influencing connector joint details, methods of computing sizes of structural members, discussion of joints loaded parallel to grain and at angle to grain, formulas for determining stresses in members with combined bending and axial loads. Recommended procedure for designing timber connector structures is given in detail and examples illustrating the necessary steps are included.

Inserted with the booklet is a four-page, loose-leaf pamphlet which illustrates the load variations for timber connectors with different end distances, edge distances, spacings, and angle of load to grain.

The booklet is being distributed to engineers, architects, professors, and students of engineering. Timber Engineering Co., Washington, D. C.

A NEW Horse-Drawn Mower — by the Leading Tractor Builder

The McCormick-Deering No. 9 *Zerol-gear* Mower is a 2-horse mower with fully enclosed "two-step" transmission. The gears are located behind the axle, thus tending to balance the weight.



INTERNATIONAL Harvester pioneered in the forward march of tractor power when, over 30 years ago, the Titan and the Mogul led the way to a new day of efficiency on farms throughout the world. Later came the Farmall, bringing to thousands the first successful row-crop tractor. Today, Harvester is the world's leading tractor builder—*and it is a leader also in the manufacture of quality horse-drawn* equipment. Any man who farms with horses can find the *modern* implement he needs in the McCormick-Deering line.

The new McCormick-Deering No. 9 *Zerol-gear* Mower is a good example of Harvester's modernization policy for horse farmers. The No. 9 is an extremely smooth, quiet-running mower. Its gears are fully enclosed and automatically lubricated by a bath of oil. The transmission is the new *Zerol-gear* type, proved by test to be the most efficient ever used in a horse-drawn mower.

Available in plain or vertical lift, the No. 9 has convenient, latchless levers; automatic pitman connection; an improved pitman box connection; and many other distinctive features which add to the efficiency and durability of this machine.

In the No. 9 Mower, bevel gear and pinion are *Zerol-type*, a new curved-tooth gear which combines certain characteristics of both spiral-tooth and straight-tooth bevel gear

INTERNATIONAL HARVESTER COMPANY
180 NORTH MICHIGAN AVENUE CHICAGO, ILLINOIS

McCORMICK-DEERING

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

JUNIOR ENGINEER, ($2000). The U. S. Civil Service Commission announces an unassembled examination for junior engineers, any branch, to meet an increasing need for their services in national defense work. Persons who have eligible ratings under previous junior engineer examinations within the past year need not apply again, as their eligibility will continue during the life of the register resulting from this examination. College graduation in engineering is required, but applications will be accepted from senior students. Applications on Form No. 8 may be filed at the Commission's Washington office until December 31, but positions are open now and applications will be rated as received. The age limit is 35 years. Details are explained in announcement No. 51.

ENGINEERS (various grades, $2,600 to $5,600). The U. S. Civil Service Commission announces an unassembled examination for engineers, in grades from assistant to principal engineer, in all branches except chemical, metallurgical, marine, and naval architecture, for which previous announcements are still in effect. Agricultural engineers qualified in farm machinery are indicated in a list of those particularly needed in connection with the national defense program. The age limit is 60 years. Provisions for substitution of qualifying professional experience for formal education, and of graduate study in engineering for professional experience have been made more liberal. Applications will be rated as received until June 30, 1942, but qualified persons are urged to file their applications at once. Details are explained in announcement No. 69, issued April 7, 1941.

RESEARCH WORKER wanted July 1st. Inauguration of a research program in farm equipment in the South will require graduate in agricultural engineering with farm background. Consideration given only to man with inventive and mechanical turn of mind who is not subject to Selective Service Act. Salary up to $3,000, depending upon qualification. PO-128

RESEARCH WORKER wanted. Inauguration of research program in farm structures in a southern state requires high type man with research experience. Problems in crop storages and animal shelters predominate. Consideration given only to man with farm background who can take the initiative and who is not subject to the Selective Service Act. Salary up to $2700, depending upon qualifications. PO-129

POSITIONS WANTED

AGRICULTURAL ENGINEER, 1935 graduate from an eastern college with 5½ years experience with the Soil Conservation Service as camp engineer, assistant project engineer, project hydraulic engineer working on watershed and hydrologic studies, and now on an S.C.S. flood control survey party, desires change to position involving work with farm machinery or mechanical equipment. Good farm machinery background and natural mechanical and inventive ability. Age 31. Married; 1 child. Selective Service classification, Group 3A. Available immediately. PW-336

AGRICULTURAL ENGINEER (Senior, graduating in June) with nine months' drafting experience on farm building plan service at a southern institution, is particularly interested in gaining experience in farm structures work. Available for employment June 15 to September 15. PW-337

AGRICULTURAL IMPLEMENT BLOCKMAN, with three years in agricultural engineering work in engineering college and eleven years experience with large manufacturer of farm equipment, desires position as teacher in farm shop, national defense, or farm machinery research work. Age 37. Health excellent. No defects or bad habits. Married. Rural background. Complete credentials furnished upon request. Best of references. Available July 1, 1941. PW-338

AGRICULTURAL ENGINEER with BSc in agriculture; BSc in electrical engineering; MS with work specializing in heating, ventilation, refrigeration; two years engineer with Soil Conservation Service; six years of teaching and research in all phases of agricultural engineering including three as assistant professor of agricultural engineering. Interested in promotional, development, or research work in rural electrification program of a college, utility, or other organization. PW-339